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EDUCATION FOR A CHANGING WORLD OF WORK, REPORT OF THE PANEL OF CONSULTANTS ON VOCATIONAL EDUCATION. APPENDIX I, TECHNICAL TRAINING IN THE UNITED STATES.

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DESCRIPTORS- *TECHNICAL EDUCATION, TASK PERFORMANCE, *TECHNICAL OCCUPATIONS, *EMPLOYMENT OPPORTUNITIES, *STUDENT ENROLLMENT, ENROLLMENT TRENDS, EMPLOYMENT TRENDS, EDUCATIONAL PROGRAMS, PROGRAM DESCRIPTIONS, *CURRICULUM, CURRICULUM PROBLEMS, EDUCATIONAL RESEARCH, GUIDELINES, FEDERAL LAWS, CORRESPONDENCE STUDY, JOB TRAINING, INDUSTRY, MILITARY TRAINING, TECHNICAL INSTITUTES, COMMUNITY COLLEGES, AREA VOCATIONAL SCHOOLS, HIGH SCHOOLS, PART TIME STUDENTS, EVENING STUDENTS, PANEL OF CONSULTANTS ON VOCATIONAL EDUCATION,

THIS REPORT DEALS WITH TECHNICAL EDUCATION AND THE PART IT PLAYS IN PROVIDING TRAINED TECHNICIANS AND OTHER TECHNICAL WORKERS FOR AMERICAN INDUSTRY. RAPID TECHNOLOGICAL CHANGE IS INCREASING THE PROPORTION OF BOTH MALE AND FEMALE SEMIPROFESSIONAL TECHNICAL WORKERS IN INDUSTRY, AGRICULTURE, BUSINESS, MEDICINE, AND HEALTH. THE GEOGRAPHIC MOBILITY OF INDUSTRY HAS WIDENED THE DISTRIBUTION OF SUCH WORKERS AND THEREBY INCREASED THE DEMANDS ON TECHNICAL EDUCATION IN VARIOUS REGIONS. ALTHOUGH SOME PROJECTIONS INDICATED AN ANNUAL NEED FOR 67,800 TECHNICIANS BY 1970, ANOTHER BASED ON A 2 TO 1 RATIO BETWEEN TECHNICIANS AND ENGINEERS, INDICATED AN ANNUAL NEED FOR 200,000. THE PROJECTED POTENTIAL POST-SECONDARY TECHNICAL EDUCATION ENROLLMENT FOR 1970 IS 590,000 FULL-TIME STUDENTS. THE 140,000 NEW WORKERS NEEDED TO BE TRAINED ANNUALLY IN EDUCATIONAL INSTITUTIONS WILL REQUIRE AN ENROLLMENT OF SOME 390,000 FULL-TIME STUDENTS, WITH AN ENTERING GROUP EACH YEAR OF 240,000. PRESENT FULL-TIME TRAINING PROGRAM ENROLLMENTS ARE ESTIMATED TO BE 60,000 STUDENTS--FAR SHORT OF THE NEEDS. THE OVERALL COST OF A PROGRAM THAT WILL MEET THE NEEDS AS OUTLINED IN THIS REPORT WOULD AMOUNT TO ABOUT $1.5 BILLION DOLLARS FOR PLANT AND EQUIPMENT FOR FULL-TIME STUDENTS IN POST-SECONDARY INSTITUTIONS AND ABOUT $300 MILLION FOR ANNUAL OPERATING COSTS. EXTENSIVE CONCLUSIONS, RECOMMENDATIONS AND ISSUES ARE INCLUDED. THE COMPLETE REPORT IS AVAILABLE AS VT 005 454, A SUMMARY AS VT 001 796, AND OTHER APPENDIXES AS VT 005 455 AND VT 001 306. THIS DOCUMENT IS AVAILABLE AS FS5.280--80022 FOR $1.25 FROM SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. 20402. (EM)

APPENDIX I

Technical Training in the United States

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The report is contained in the following publications:

Summary Report, Publication No. OE-80020, 24 pp., 30¢.

Report, Publication No. OE-80021, 296 pp., $1.25.

Appendix I, *Technical Training in the United States*, by Lynn A. Emerson, Publication No. OE-80022, 170 pp., $1.25.

Appendix II, *Manpower in Farming and Related Occupations*, by C. E. Bishop and G. S. Tolley, Publication No. OE-80025, 51 pp., 35 cents.

Appendix III, *The Economic and Social Background of Vocational Education in the United States*, by Harold F. Clark—*A Sociological Analysis of Vocational Education in the United States*, by Wilbur B. Brookover and Sigmund Nosow—*The Case for Education for Home and Family Living*, by Bernice Milburn Moore—*The Contribution to the National Economy of the Use of Resources Within and By the Family*, by Elizabeth E. Hoyt, Publication No. OE-80026, 91 pp., 50 cents.

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OE-80022

EDUCATION
FOR A CHANGING WORLD OF WORK

APPENDIX I

Technical Training in the United States

By Lynn A. Emerson

Report of the Panel of Consultants on Vocational Education
Requested by the President of the United States

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Office of Education

The material in this publication was prepared under a contract with the United States Office of Education authorized by the Panel of Consultants on Vocational Education. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy. This document has been printed exactly as it was submitted in final form by the contractor.

This report was made by
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Foreword

In his Message to Congress on American Education, February 20, 1961, President John F. Kennedy said:

> The National Vocational Education Acts, first enacted by the Congress in 1917 and subsequently amended, have provided a program of training for industry, agriculture, and other occupational areas. The basic purpose of our vocational education effort is sound and sufficiently broad to provide a basis for meeting future needs. However, the technological changes which have occurred in all occupations call for a review and re-evaluation of these acts, with a view toward their modernization.
>
> To that end, I am requesting the Secretary of Health, Education, and Welfare to convene an advisory body drawn from the educational profession, labor, industry, and agriculture, as well as the lay public, together with representatives from the Departments of Agriculture and Labor, to be charged with the responsibility of reviewing and evaluating the current National Vocational Education Acts, and making recommendations for improving and redirecting the program.

On October 5, 1961, The White House announced that the Secretary of Health, Education, and Welfare had appointed the President's Panel of Consultants on Vocational Education.

The Panel began work with its staff in Washington, D.C. on November 9-11, 1961. Subsequently the Panel met on March 7-10, May 3-5, July 14-16, September 15-18, October 6-7, October 27-28, and concluded its review at a final meeting, November 26-27, 1962.

The Panel conferred with various consultants and commissioned special studies in addition to those prepared by its staff, and the Division of Vocational and Technical Education, Office of Education, U.S. Department of Health, Education, and Welfare. The Panel also convened for its guidance a number of special conferences on the educational aspects of our national manpower resources and requirements.

The Panel of Consultants has thus had advice, suggestions, and recommendations from many persons representing a cross-section of the American people: those who produce and distribute the goods and services which the Nation requires; those who are responsible for the educational development of the Nation; and those who take a general interest in the Nation's social and economic well-being. The members of the Panel themselves are a representative group of citizens who believe in the importance of education and who have tried to use reliable information and methods of analysis in order to formulate the recommendations which are presented in its report.

Benjamin C. Willis
Chairman

PREFACE

This report deals with technical education of semiprofessional level and the part it plays in providing trained technicians and other technical workers for American industry. It presents a picture of technical occupations in industry, and looks at the needs for workers to fill these jobs. It discusses the ways in which such workers are trained, and the programs used for such training. It appraises the extent to which current needs are being met, and projects the relation between needs and facilities to the years immediately ahead. It makes some recommendations for meeting these needs.

The topic is a timely one. In "The Aims of Education," published in 1917, Alfred North Whitehead said this:

> "In the conditions of modern life the rule is absolute, the race which does not value trained intelligence is doomed. Not all your heroism, not all your social charm, not all your wit, not all your victories on land or at sea, can move back the finger of fate. Today we maintain ourselves. Tomorrow science will have moved forward yet one more step, and there will be no appeal from the judgment which will then be pronounced on the uneducated."

In modern industry the engineer and scientist are concerned with such new developments as cryogenics, magnetohydrodynamics, microminiaturization, space communications systems, and laser development engineering. No longer does the engineer find time to perform many of the tasks that fell to his lot in former years. He needs technical support in the form of technicians to take over such tasks. The training of these technicians is one of the vital jobs to be done in America today.

In preparing the material in this report I have utilized all the pertinent publications available to me, and have communicated with a number of leaders in the field. I have used freely the data thus obtained. Many of the statements in this report have grown out of a relatively long working experience in the field. During the past fifty years I have served as a technician and engineer in industry; as an instructor, department head, and director in vocational-technical training institutions; as a city and State supervisor of industrial education; as assistant dean of an engineering college; as a professor of industrial and technical education; and as a consultant on industrial and technical education with State and national governments at home and abroad. These experiences have permitted me to see technical education from the standpoint of the engineering college as well as the vocational-technical school, and on a national basis as well as a local one.

In preparing this report I have tried to present as unbiased a picture as possible in appraising the strengths and weaknesses of the different types of educational institutions. The data presented here from published reports are believed to be correct. The estimates made have been developed in accord with the best procedures of which I am aware, in the light of the data available. It is hoped that the report will be useful to the Panel of Consultants in their deliberations concerning recommendations for future legislation in the field of technical education.

Chevy Chase, Maryland
June, 1962

Lynn A. Emerson

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1. TECHNICAL OCCUPATIONS IN INDUSTRY

Rapid technological development in American industry is causing widespread changes in industrial occupations. Former occupations are acquiring new characteristics. New types of jobs are emerging. Tasks previously performed by one group of workers are now done by others. New job titles and new job classifications are found in the personnel records.

One of the most significant changes is the rapid growth of occupations which lie between the fields of the skilled crafts and engineering. This group contains many new jobs of technical character, varying widely in scope and level of the tasks performed, and in the nature of the activities carried out. Among the workers in these jobs is a group which has come to be known as technicians. They are taking over many of the tasks previously handled by engineers, and are serving in many occupations not known in industry only a few years ago. The group is not easily identified. On the one hand, it has many many of the characteristics of engineering; on the other, many of the activities associated with the skilled trades. Some technician jobs lean toward the engineering type, such as jobs which consist mainly of drafting and design, computations, and laboratory testing. Others border on the skilled trades, such as those which deal with maintenance of technical equipment where much technical "know-how" is demanded but which also require considerable manual skill.

The kinds of technical ability found in the various technician jobs are of considerable variety. Some jobs emphasize analysis and diagnosis. Some require visualization of drawings, or a flair for creative design. Some demand a high degree of applied mathematical ability. Some require knowledge of practices in the skilled trades, but not the ability to perform the skilled tasks. Some require extensive understanding of industrial equipment and processes. Sometimes the job involves supervisory or management responsibilities, and combines skill in dealing with people with skill in handling technological problems.

One method of comparing groups of occupations within industry is to consider the relative amounts of physical effort and mental effort demanded from the worker. In some occupations the worker devotes most of his time and energy to manipulative work with materials, tools, and machines. Other occupations consist more largely of mental effort. The skilled craftsman gives most of his energy to manipulating the tools of his trade. The engineer, on the other hand, spends most of his time thinking through his various problems. Between these extremes lie the occupations which have come to be known as technician jobs, which usually involve some manipulative work along with a considerable amount of mental effort.

As shown in Figure 1, the relative amounts of manipulative and technical skill effort required of the worker differ considerably as one compares the skilled production worker with the technician or the engineer. Within each group of occupations there also are differences. In some skilled crafts the proportion of time required in mental effort is much greater than in other crafts. Similarly one finds great differences within the group of technician occupations. There is no clearcut demarkation between groups. Craft occupations

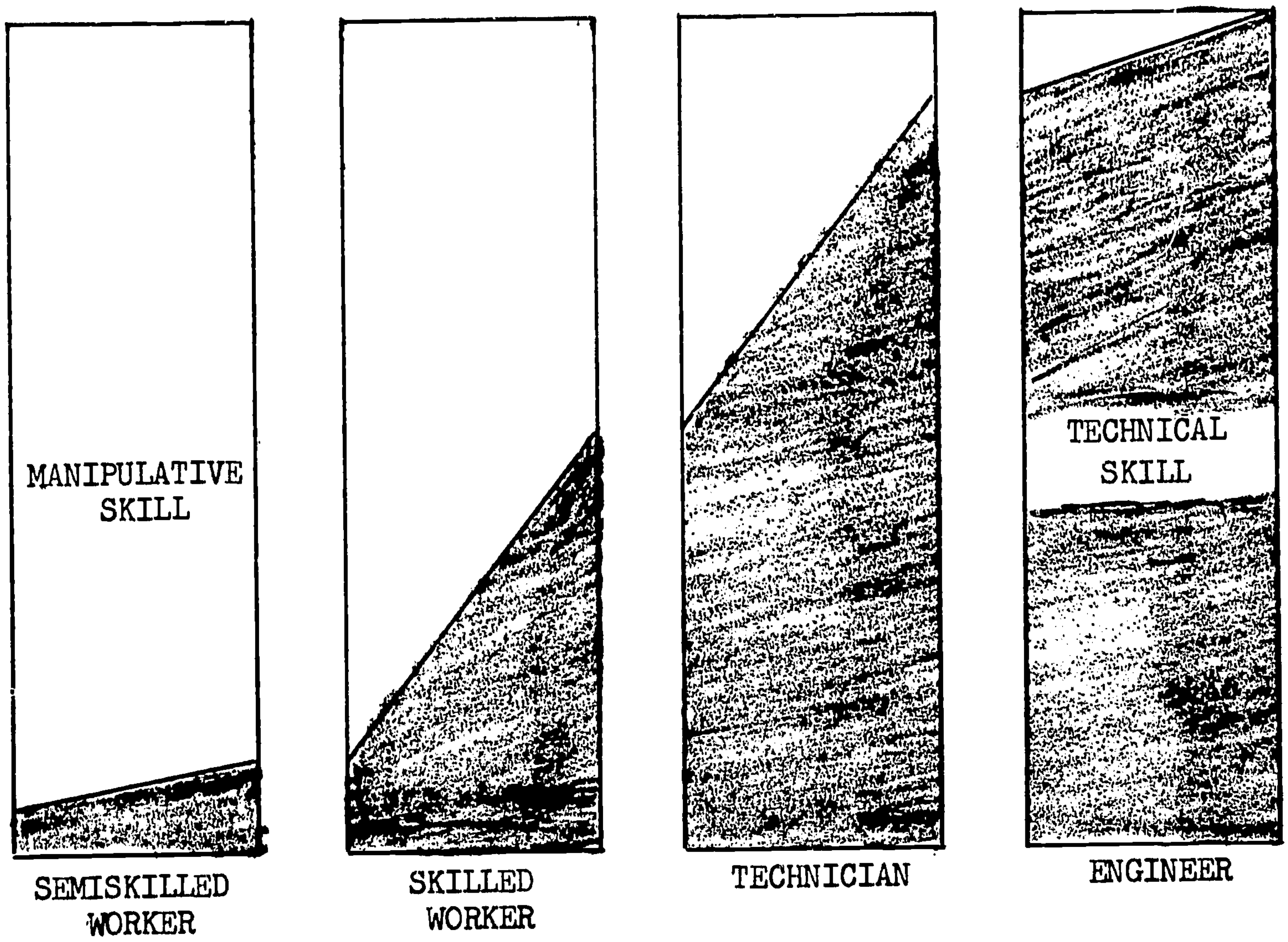


Figure 1. Manipulative and Technical Skills of Industrial Workers

merge into technician occupations, and the designation of an occupation as in one category or the other is sometimes difficult. A rough measure that may be useful to distinguish between them is to designate the occupation as of technician character if the worker spends more than half his time in tasks that are mental rather than manipulative.

A comparative listing of skilled crafts occupations and technician occupations in the same field sometimes is helpful in getting a picture of the nature of technician jobs. Table I shows such listings for the metal products manufacturing and the construction fields.

TABLE I. SKILLED CRAFTS AND TECHNICIAN OCCUPATIONS IN METAL PRODUCTS MANUFACTURING AND CONSTRUCTION

	Skilled craftsmen	Technicians
Metal Products Manufacturing	Machinist	Tool designer
	Toolmaker	Tool inspector
	Moulder	Draftsman
	Steamfitter	Time/motion-study man
	Electrician	Assembly technician
	Millwright	Expediter
	Plumber	Automated machine maintenance technician
	Patternmaker	Technical supervisor
	Etc.	Etc.
Construction	Bricklayer	Architectural draftsman
	Stonemason	Structural draftsman
	Tilesetter	Topographical draftsman
	Plasterer	Estimator
	Carpenter	Building inspector
	Painter	Equipment salesman
	Plumber	Air conditioning technician
	Steamfitter	Materials man
	Electrician	Highway engineering aide
	Sheetmetal worker	Expediter
	Structural steel worker	Specification writer
	Welder	Technical equipment installation supervisor
	Etc.	Etc.

Occupations within industry cannot be classified into watertight compartments. No matter what classifications are used, many occupations are borderline and might be classified in one group or another. Jobs are changing so rapidly that any classification system cannot remain static. Workers called skilled craftsmen in one organization may be classified as technicians in another organization. And persons designated by the title of engineer in one company may be called technicians in another.

Ordinarily we use classifications in industry which denote broadly the nature of the work done -- such as production workers, maintenance workers, salesmen, supervisors, research and development workers, and the like. But such broad groupings tell little about the level of the work, or the real nature of the activities involved. A production worker may perform very simple repetitive operations or he may check the final assembly of an intricate electronic device. The maintenance worker may replace burned out flourescent tubes or he may diagnose and repair trouble in a complicated automated machine. The salesman may sell items in a hardware store or a complicated system of refrigeration for a large building. The research and development worker may perform minor tasks in a research laboratory or be concerned with working out a complicated scientific problem involving a breakthrough in technology. One job shades into another in each category, with a resulting continuum of job levels.

Sometimes we classify occupations from the standpoint of the training the worker has received, as is often the case with the engineer. But this practice has more of the aspects of a licensing system that of job classification. If we limit our concept of a technician to a person who has been graduated from an institution known as a technical institute, we are falling into this pattern. If we have to classify workers, many factors need to be taken into account if good classifications are to be achieved -- the nature of the work done, the level of the work, the background required if the work is to be done properly, the creative abilities needed, the management abilities required, and a host of others.

In the field of technical occupations within industry the jobs vary from simple technical jobs learned in a very short time to very complicated jobs requiring long training and experience. Classifying them is difficult, and clear-cut allocation of all jobs into classifications is impossible. Yet without some scheme of classification, imperfect though it may be, it is difficult to get an overall grasp of the field of technical occupations in its setting in the industrial economy. In the absence of a generally accepted system, the writer of this report suggests the classifications for technical workers as shown in Figure 2 -- narrow-scope limited-level technical occupations, technical specialist occupations, industrial technician type occupations, and engineering technician type occupations.

Within the group of technical occupations in industry one finds great variations in the range of content with which the worker must deal, and in the level of intellectual ability and technical background which the worker must have in order to perform his tasks. Some of these occupations have certain technical aspects but are of very narrow scope and require a relatively limited level of technical understanding. Examples are routine inspection of

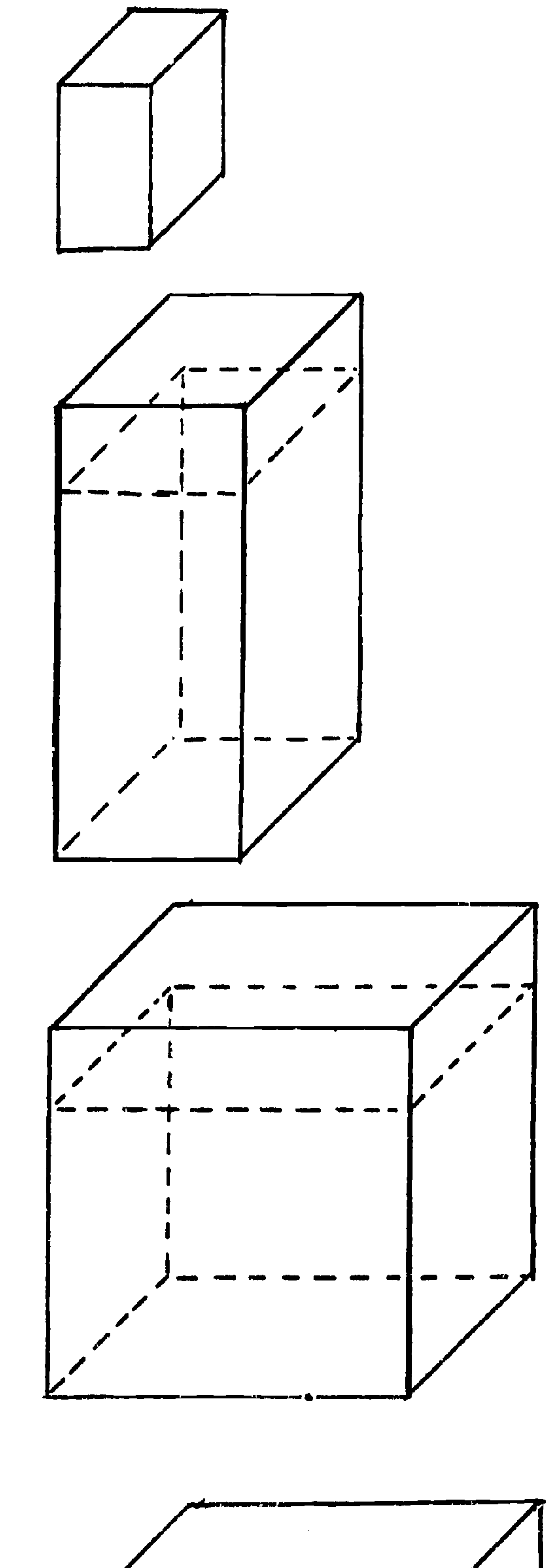
components in the manufacture of a product, and simple testing of materials or products. Training for such jobs usually is provided through on-the-job instruction, or through short, intensive courses.

Some jobs of technical character deal with a fairly narrow scope or range of content but require a high level of ability within that range. These jobs are sometimes called technical specialist occupations. For example, the television maintenance worker may deal only with the servicing of television receivers and radio receivers, but he is required to know a considerable amount about electronic principles and their applications to television sets, about malfunctions that occur in such equipment, and the use of test instruments in locating trouble. Such a person needs a fairly high level of technical competency even though his work is confined to television servicing.

The technicians whose jobs cover relatively wide scopes, and which require a high level of mathematical, scientific and applied technological ability are frequently classified as engineering technicians . Such jobs as engineering aide, tool designer, instrumentation technician, and electronics technician are in this category. The education of the engineering technician is broad enough to prepare him for handling a considerable range of tasks within his general field as assistants to engineers or scientists, or in work of a varied type. Frequently the work of the technical specialist deals with one facet of the broader scope of the work of the engineering technician.

Industry employs many technicians whose duties do not demand quite as high a level and scope of mathematical and scientific background as that required by the engineering technician, but include broader understandings of industrial processes, production methods, and technical and mechanical skills of maintenance. Such technicians are coming to be known as industrial technicians. Their jobs frequently involve supervisory responsibilities. Job titles in this group include quality control technician, assembly technician, instrument maintenance technician, production technician, and the like.

Figure 2 illustrates the scope and level of these different types of technical occupations. It should be kept in mind that there are no firm dividing lines between the types illustrated. Technical occupations form a continuum, from the lowest level of job to the highest type of engineering technician. All of them are needed in modern industry.



A. <u>Narrow-scope limited-level technical occupation</u>, requiring simple technical skills and a relatively short learning period. Not considered a "technician" occupation.

B. <u>Technical specialist occupation</u>, with somewhat narrow scope but high level of ability needed within that scope. Training period usually shorter than that required for "industrial-type technician" and "engineering type technician."

C. <u>Industrial-type technician occupation</u>, usually of fairly broad scope and high level of ability needed. Training period needed may approximate or equal that for the "engineering-type technician." Training content may include less higher mathematics but more applied technology than that for the engineering-type technician. Occupations of this type may include technical maintenance jobs of broad scope, technical production jobs, and the like.

D. <u>Engineering-type technician occupation</u>, of broad scope and high level of ability needed, usually requiring training equivalent to a two-year full-time program of post high school level, rigorous in nature, including mathematics, science and applied technology pertinent to the field of specialization. Persons in these occupations have sufficient background to be able to work effectively as aides to engineers and scientists.

FIG. 2. Types of Technical Occupations in Industry

Tasks Performed by Technicians

The range of the various tasks performed by the different types of technicians is great. Here are some of them:

- Making drawings - mechanical, electrical, topographical
- Making charts and technical illustrations
- Analyzing and interpreting plans and designs
- Working out details of designing
- Performing mathematical computations
- Using computing devices such as slide rule and calculating machines
- Making cost estimates of labor, materials and equipment
- Performing laboratory and operation tests of instruments and equipment
- Testing the properties of materials
- Making quantitative chemical analyses
- Inspecting components, products, machines, instruments, structures
- Analyzing production costs
- Planning production layouts and production flow
- Making time and motion studies
- Supervising production and assembly processes
- Supervising construction projects
- Diagnosing trouble in technical equipment
- Checking and adjusting production-control and testing instruments
- Supervising installation of technical equipment
- Marketing technical equipment and products
- Rendering direct assistance to engineers and scientists in details of their work
- Preparing formal reports on tests or other projects
- Preparing specifications
- Writing technical manuals, bulletins, and sales promotion materials
- Operating and controlling automated production systems
- Operating complicated electronic communication equipment
- Servicing highly technical equipment
- Performing liaison service between engineering and production

These tasks vary from one occupational field to another. No individual technician performs all of them. A summary of these tasks is as follows:

Computing	Writing reports
Inspecting	Using handbooks
Measuring	Troubleshooting
Analyzing	Expediting
Diagnosing	Controlling production
Interpreting	Planning production
Using instruments	Making experimental equipment
Using hand tools	Writing specifications
Making drawings	Supervising technical operations
Sketching	Maintaining automated equipment
Detail designing	Operating large automated systems
Recording data	Selling technical products
Testing	Building prototype models

In order that these tasks may be carried out effectively, technicians need extensive background of training and experience. Here are some of the requirements:

A high degree of applied mathematical ability
Skill in analysis and diagnosis of technical problems
A solid background of basic physics and/or chemistry
Experience in the skilled crafts or understanding of craft processes
Extensive understanding of industrial equipment and industrial processes
Skill in precise methods of work, as in measurements and instrument adjustment
Sales ability
Cost accounting ability
Skill in dealing with people
Supervisory and management ability
Proficiency in the use of pertinent hand tools and machine tools
Ability to write or illustrate technical material
Extensive background in the technology of the field in which the technician works
A scientific approach to the tasks of the occupation

No single technician requires all of the attributes and abilities listed above. The engineering technician, however, will need most of them.

Criteria for Identifying Technician Occupations

Title VIII of the National Defense Education Act provides funds for the training of highly skilled technicians. The Area Vocational Education Branch of the U.S. Office of Education, which is concerned with this phase of the Act, has prepared suggestive criteria for identifying such technician occupations. The criteria take the form of five general abilities considered as essential to all highly skilled technician occupations, and twelve specific criteria. The general criteria establish the framework for levels of competency, and specific criteria are examined in the light of the general criteria. For suggestions concerning the use of these criteria the reader is referred to the Office of Education bulletin, from which the following are taken: (60):

GENERAL ABILITIES

1. Facility with mathematics; ability to use algebra and trigonometry as tools in the development of ideas that make use of scientific and engineering principles; an understanding of, though not necessarily facility with, higher mathematics through analytical geometry, calculus, and differential equations, according to the requirements of the technology.

2. Proficiency in the application of physical science principles, including the basic concepts and laws of physics and chemistry that are pertinent to the individual's field of technology.

3. An understanding of the materials and processes commonly used in the technology.

GENERAL ABILITIES (Continued)

4. An extensive knowledge of a field of specialization with an understanding of the engineering and scientific activities that distinguish the technology of the field. The degree of competency and the depth of understanding should be sufficient to enable the individual to do such work as detail des[illegible]ing established design procedures.

5. Communication skills that include the ability to interpret, analyze, and transmit facts and ideas graphically, orally, and in writing.

<u>Criteria for Identifying Occupations that Require Technical Education</u>

The individual in the occupation:

1. Applies knowledge of science and mathematics extensively in rendering direct technical assistance to scientists or engineers engaged in scientific research and experimentation.

2. Designs, develops, or plans modifications of new products and processes under the supervision of engineering personnel in applied engineering research, design, and development.

3. Plans and inspects the installation of complex equipment and control systems.

4. Advises regarding the maintenance and repair of complex equipment with extensive control systems.

5. Plans production as a member of the management unit responsible for efficient use of manpower, materials, and machines in mass production.

6. Advises, plans, and estimates costs as a field representative of a manufacturer or distributor of technical equipment and/or products.

7. Is responsible for performance or environmental tests of mechanical, hydraulic, pneumatic, electrical, or electronic components or systems and the preparation of appropriate technical reports covering the tests.

8. Prepares or interprets engineering drawings and sketches.

9. Selects, compiles, and uses technical information from references such as engineering standards, handbooks, and technical digests of research findings.

10. Analyzes and interprets information obtained from precision measuring and recording instruments and makes evaluations upon which technical decisions are based.

11. Analyzes and diagnoses technical problems that involve independent decisions.

12. Deals with a variety of technical problems involving many factors and variables which require an understanding of several technical fields.

Some of these twelve criteria are broadly inclusive. Others describe specific functions. No single technical occupation would require all of the items, and appropriate weighting should be used. The Office of Education bulletin emphasizes that no single criterion should be considered as definitive unless the level of competence being exercised is within the framework of the five ability requirements.

The foregoing criteria were designed for the purpose of identifying highly skilled technician occupations. It must be kept in mind that many other technical occupations are found in industry, occupations which do not require as wide a scope or as high a level of technical ability as is needed by the engineering or industrial technician. Workers in these occupations form an important part of the total industrial work teams.

Broad Fields of Technician Work

Technician occupations are found in many facets of modern life; in research, design, development, production, construction, installation, marketing, operation control, maintenance, service inspection, personal service, and the like. The following broad groupings are suggested to help provide a picture of the scope of technician activities.

Research, design, and development

Technicians in this field are largely of the engineering aide type, whose functions are mainly concerned with assisting the engineer and the scientist by carrying out the more routine tasks, done in former years by the engineer and the scientist. Among these tasks are computing, drafting, detail designing, testing, report writing, and liaison with production and construction activities. Among the payroll titles of technicians in this group are mechanical draftsman, structural draftsman, reinforcing steel detailer, electronics draftsman, machine designer, tool designer, laboratory technician, electrical equipment tester, pilot-plant operator, engineering aide, and many others.

Manufacturing production

These technicians are concerned with various aspects of production planning and control. Some are staff assistants; others are of technical supervisor type. Many of the jobs have some management characteristics combined with the technical duties. Typical job titles are plant layout

technician, production control supervisor, quality control technician, time and motion study man, control analyst, tool inspector, expediter, and job methods technician.

Marketing of technical products

Many engineers are employed in the technical sales field, but technicians are entering this type of work in increasing numbers. Their jobs involve appraising customers' needs, suggesting appropriate equipment or construction to meet the needs, preparing specifications for special adaptations, and drawing up sales contracts.

Construction and installation

In highway and heavy construction, technicians serve in liaison capacity between the engineer and the contractor, and as aides to the contractor in various technical tasks. They serve as highway engineering aides, construction supervisors, materials testers, construction cost accountants, as inspectors of work in progress and completed jobs. Many technicians are also employed in the supervision of the installation of technical equipment of various types -- electrical, electronic, automated machines, chemical processing equipment, computers, and the like.

Operation control

The operation of highly technical equipment such as radio/television transmitters, power station networks, large automated manufacturing units, radar stations, and some phases of atomic energy production, are in this category.

Maintenance and inspection service

The maintenance of highly technical equipment utilizes many technicians competent in trouble shooting. The routine preventive maintenance often can be handled by persons with limited training, but when trouble occurs the technician is needed. The jobs involve electrical, electronic, and mechanical equipment, and effective trouble diagnosis often requires competence in all of these fields. Technical inspection service is found in the aircraft, missile, and other fields. Government employs many technicians in the field of inspection.

Miscellaneous technician occupations

Some technician occupations cut across several of the categories previously listed, yet have their own characteristics. Among these are technical writing and technical illustration, used in the preparation of printed materials for sales promotion, employee training activities, service manuals, and the like. Data processing technicians may be concerned with engineering data or with business data processing. The technical secretary uses office skills in working with technical information. The technical service correspondent's job utilizes the technology of his special field in his correspondence.

Technical Occupations in Fields Outside Industry

Most technicians find their jobs within industrial establishments, or with agencies concerned with industrial products. Yet there are many occupations of technician type and level in other fields. In the field of medical and health services we find dental laboratory technicians, dental assistants, medical assistants, medical laboratory technicians, optical technicians, and others. In merchandising, insurance, real estate, banking, office practice, etc., are found many jobs requiring specialized information and understandings of a level comparable with that needed by technicians in industry. Agriculture and its related occupations in food and fiber processing, and in sales and service occupations, employ many persons of technician type and level.

Technician Occupations

The range of occupational titles for jobs of technician character is very great, and it is difficult to classify the jobs into occupational groupings. Some types of jobs, such as various types of production technicians, are found in almost all types of manufacturing. This is also true of many types of technical service occupations. Some jobs are found only in a specific industry. The following listing of technician occupations is presented to provide an overview of the great range of these occupations.

Aeronautical technician occupations

- Aerodynamics analyst
- Aircraft electronics technician
- Aircraft flight technician
- Aircraft instrument technician
- Aircraft maintenance supervisor
- Aircraft parts inspector
- Aircraft quality control technician
- Airframe designer
- Airframe maintenance supervisor
- Airframe structural test technician
- Airport control tower operator
- Draftsman
- Electrical experimental technician aircraft
- Engineering designer, aircraft structures
- Engineering propulsion development technician, rockets
- Engineering liaison technician
- Final assembly inspector
- Flight engineer
- Flight line inspector
- Mathematics technician
- Power plant test technician
- Production controller
- Production planner
- Quality control technician
- Rocket engine design technician
- Stress analyst
- Systems technician
- Technical field representative
- Technical writer
- Technical illustrator
- Test data analyst
- Test laboratory technician
- Test technician, guidance systems
- Weight analyst
- Wind tunnel technician

Air conditioning, heating, and refrigeration technician occupations

- Air conditioning technician
- Applications specialist
- Contractor or dealer
- Controls specialist
- Development technician
- Draftsman
- Estimator and layout technician
- Heating estimator
- Heat pump specialist
- Heating plant superintendent
- Industrial equipment designer
- Installation supervisor
- Laboratory test technician
- Manufacturer's representative
- Quality control technician
- Residential equipment designer
- Sales representative
- System designer
- Test and service specialist

Atomic energy technician occupations

- Biological technician
- Chemical analyst
- Decontamination technician
- Development reactor technician
- Draftsman
- Designer
- Electronic technician
- Engineering aide
- Health physics technician
- Instrument technician
- Mathematics aide
- Medical technician
- Radiation technician
- Technical writer

Building construction technician occupations

- Architectural draftsman
- Building appraiser
- Building construction supervisor
- Building cost estimator
- Building contractor aide
- Building equipment inspector
- Building inspector
- Computer
- Concrete inspector
- Construction cost accountant
- Construction foreman
- Construction materials salesman
- Construction superintendent
- Engineering aide
- Expediter
- Junior architectural designer
- Materials tester
- Plans and prints expediter
- Specification writer
- Structural draftsman
- Structural inspector
- Construction equipment salesman
- Construction materials analyst

Chemical technician occupations

- Analyst
- Assistant to chemical engineer
- Assistant chemist
- Chemical production operator
- Chemicals salesman
- Chemical technician
- Control analyst
- Control chemist
- Research assistant
- Junior chemist
- Laboratory assistant
- Laboratory supervisor
- Laboratory technician
- Pilot plant operator
- Pilot plant supervisor
- Plastics technician
- Process foreman
- Production control technician
- Production supervisor
- Quality control technician
- Sales service technician
- Spectographic technician
- Technical illustrator
- Technical writer

Electrical technician occupations

- Applications specialist
- Communications technician
- Controls specialist
- Development technician, X-ray
- Electrical contractor
- Electrical cost estimator
- Electrical designer
- Electrical draftsman
- Electrical engineering aide
- Electrical equipment erector
- Electrical equipment salesman
- Electrical equipment tester
- Electrical experimental technician
- Electrical instrument technician
- Electrical laboratory technician
- Electrical maintenance technician
- Electric motor analyst
- Electro-mechanical technician
- Engineering aide
- Lighting technician
- Line supervisor
- Meter and instrument technician
- Power distribution specialist
- Power station operator
- Powerhouse load dispatcher
- Powerhouse maintenance technician
- Product designer
- Project supervisor
- Quality control technician
- Rectifier technician
- Relay specialist
- Technical service correspondent
- Technical illustrator
- Technical writer
- Test technician, motors

Electronic technician occupations

- Aircraft electronic technician
- Broadcast transmitter technician
- Communications technician
- Color television monitor
- Computer technician
- Customer service technician, radio - TV
- Design draftsman
- Electronic draftsman
- Electronic equipment testman
- Electronic control technician
- Electronic instrument inspector
- Electronic laboratory technician
- Electronic layout technician
- Electronic maintenance technician
- Electronic sales technician
- Guided missile technician
- Industrial control specialist
- Industrial electronics technician
- Manufacturer's sales representative
- Medical electronics technician
- Radar technician
- Radio-communications maintenance technician
- Radio-television production supervisor
- Recording technician
- Sound-studio technician
- Television studio technician
- Technical writer

Highway and heavy construction technician occupations

- Assistant to city engineer
- Assistant to construction superintendent
- Cartographer
- Computer
- Concrete laboratory technician
- Construction engineering aide
- Construction supervisor
- Design draftsman
- Engineering assistant
- Estimator
- Expediter
- Heavy Construction equipment salesman
- Topographer
- Highway engineering aide
- Instrument man
- Inspector
- Materials tester
- Materials inspector
- Party chief
- Photogrammetric technician
- Reinforcing steel detailer
- Specification writer
- Structural draftsman
- Surveyor
- Technical writer

Manufacturing production technician occupations

Assembly technician
Cost analysis technician
Cost estimator
Cost control technician
Industrial technician
Instrument maintenance technician
Job methods technician
Machine-load-control planner
Materials control technician
Metallurgical Technician
Methods analyst
Motion-and time-study man
Plant layout technician
Plant maintenance technician
Process description writer
Production control supervisor
Production estimator
Production expediter
Production planner
Production technician (specialty in specific industry)
Quality control technician
Safety inspector
Specifications writer
Tool planner
Tool-project man
Precision inspector

Mechanical technician occupations

Applications specialist
Automotive technician
Detailer
Diesel technician
Die designer
Engine development technician
Engineering aide, mechanical equipment
Estimator
Experimental machinist
Gas turbine technician
Instrument design technician
Laboratory technician
Machine designer
Machine tool salesman
Materials salesman
Materials testing technician
Metallurgical technician
Plastics technician
Product designer
Technical writer
Tool designer
Welding technician

Technician occupations in fields related to Industry

Computer programmer:
  Business data processing
  Engineering data processing
Dental laboratory technician
Fire protection technician
Meteorological technician
Optical technician
Purchasing technician
Technical photographer
Technical secretary

TABLE II. TYPICAL TECHNICIAN OCCUPATIONS, BY INDUSTRIAL FIELDS

OCCUPATIONAL FIELD	TYPICAL TECHNICIAN OCCUPATIONS
RESEARCH, DESIGN AND DEVELOPMENT	Engineering aide Mechanical draftsman Mathematics technician Design technician Chemical laboratory technician
MANUFACTURING PRODUCTION	Operation planner Time-study man Quality control technician Production control supervisor Job methods technician
CONSTRUCTION AND INSTALLATION	Building construction supervisor Highway engineering aide Materials expediter Estimator Air conditioning installation technician
MARKETING TECHNICAL PRODUCTS	Electronic sales technician Instrumentation sales technician Manufacturer's representatives: Air conditioning systems Machine tools, etc.
OPERATION AND CONTROL	Pilot plant operator Sound-studio technician Radar technician Power station operator Controller, automated machine department
MAINTENANCE AND INSPECTION	Computer maintenance technician Building inspector Instrument maintenance technician Service technician - automated machines Inspector - aircraft
MISCELLANEOUS FIELDS	Technical writer Technical illustrator Safety technician Technical secretary Technical correspondent

To get a picture of the extent of technician occupations in the various phases of industrial life, one might follow the stages in the life of a technical product. Figure 3 shows that technicians of one type or another are used in all of these stages.

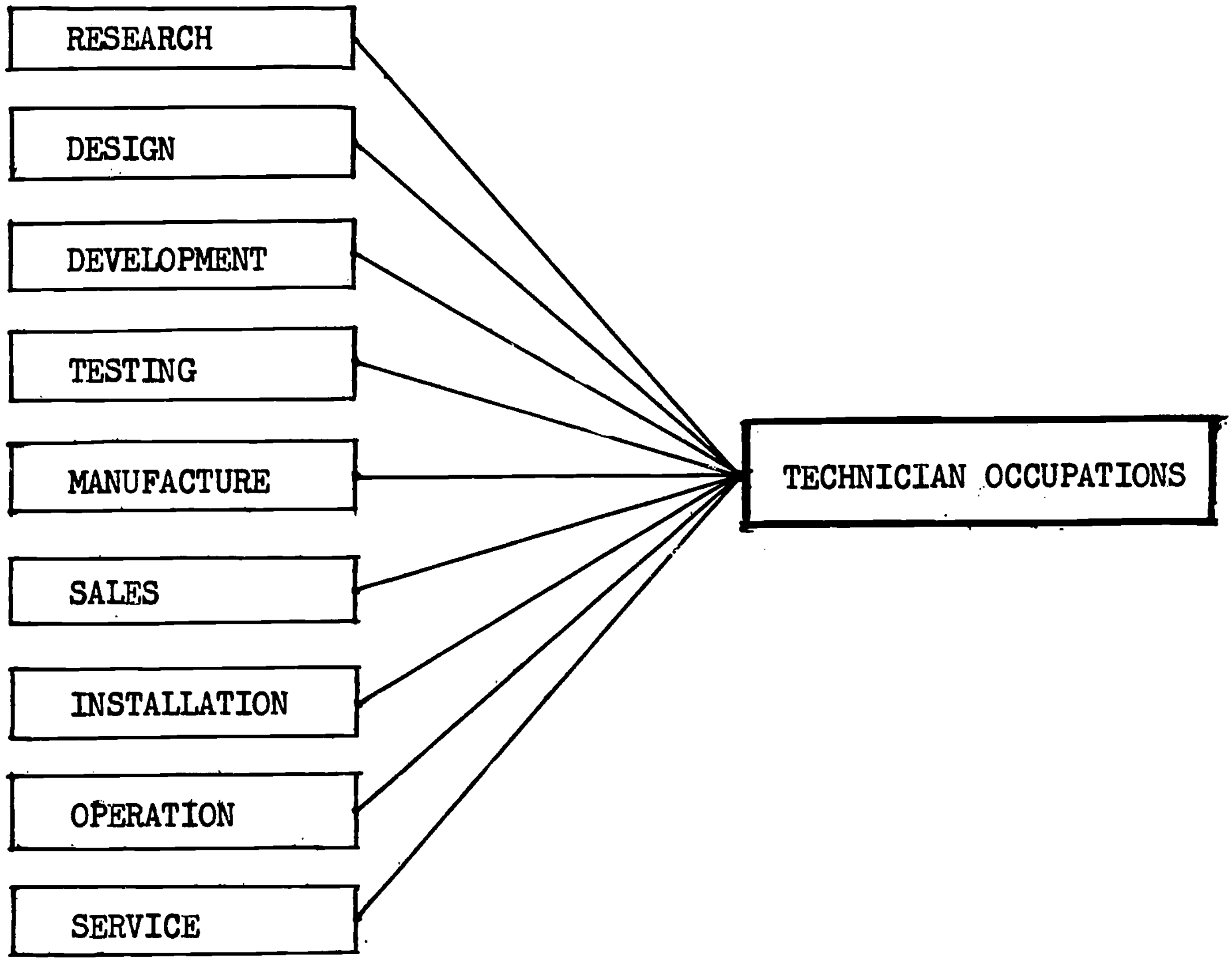


Figure 3. Technician occupations in the life of a technical product

As technology develops with constantly increasing acceleration, many changes occur in the work life of the nation. Not too many years ago the engineer had to perform most of the tasks incident to an engineering project - routine as well as broad planning. He put into sketches his ideas of the machine he was developing, made the drawings, designed the details, calculated the sizes to provide needed strength, supervised the details of building the prototype model, performed the laboratory tests on the model, devised efficient production methods, designed the tooling needed, and the like. Today he moves forward into an ever-widening field in the application of science and mathematics to new materials, new sources of power, new methods, new products. The scope of his job is so great that he must relinquish the more routine tasks. These he is passing on to the technician, whose scope of duties also is ever-widening.

Today we find such technician occupations as Rocket-engine Design Technician, Computer Laboratory Technician, Radiation Technician, Development Reactor Technician, Color Television Monitor, and Electro-mechanical Technician. These are symbolic of what lies ahead. The technician is a key person in modern industry. The development of adequate facilities for his education presents a significant challenge to American education.

Occupations of Technician Level Not Related to Engineering

The technician occupations in the foregoing lists deal with activities which might be classed as engineering-related. Many thousands of persons, however, work at jobs of technician level in fields not directly connected with industry, jobs which usually require preparation equivalent to two years of special training beyond high school. These jobs occur frequently in such fields as medical and health services, personal service of miscellaneous types, office practice, wholesale and retail merchandising, agriculture and related fields, institutional management, and government.

Examples of technician-level occupations in the medical, dental, and related fields are dental hygienist, dental laboratory technician, dental office assistant, dietitian aide, medical equipment technician, medical illustrator, medical laboratory technician (many specialties), medical office assistant, milk and food inspector, and nursing aide.

An outstanding example in the field of office practice is the recently developed group of technician occupations which deal with business data processing.

The retail merchandising field includes such occupations as advertising copywriters, buyers and assistant buyers, merchandise managers, specialty sales persons. The insurance field has its actuaries, underwriters, and claim adjusters. Banks utilize the services of credit analysts and loan examiners. The hotel field has food service managers, housekeepers, and assistant managers. Government uses many workers of technician level in fire protection, police service, safety inspection of equipment and structures, employment service, and many other fields.

Occupations of Technician Level Not Related to Engineering (Cont'd.)

Many occupations of technician level are found in the various phases of agriculture and its related occupations, such as poultry husbandry, floriculture, food and fiber processing, agricultural equipment sales and service, and the many jobs as assistants to scientists in agricultural research.

Employment of Women in Technician Occupations

To date most technician jobs have been filled by men. But there appears to be a distinct trend toward the employment of increasing numbers of women for many of these occupations. Some technician jobs which require background in mechanical trades which are almost exclusively men's occupations will no doubt continue to employ men only. But many others can be filled just as satisfactorily by women as by men. A recent occupational survey which gathered data on some fifty technical occupations showed that employers will hire women in more than three-quarters of the occupations studied. (18).

Reporting on a recent study of the employment of women as technicians, Meyer of the Women's Bureau provides the following: (37).

> "The expanding field of technical occupations offers many and varied employment opportunities to women. Technical workers, utilized by some of the fastest growing industries in our economy, are expected to be needed in ever-increasing numbers as technology and science advance.
>
> Women and girls interested in this field of employment will find a wide range of specializations among technicians. A substantial proportion of technical jobs are in the fields of engineering, electronics, electrical technology, chemistry, aeronautics, communications, and data processing. Smaller numbers of technical workers are engaged in architecture, design, construction, instrumentation, or automotive operations -- to name a few.
>
> Women are more enthusiastically accepted in some technical specializations than in others. Many more are working in research laboratories and in statistical operations than in actual manufacturing processes. Increasing numbers of women technicians are being hired in electronic research. Some employers prefer women for statistical data processing jobs and as chemical laboratory technicians. One supervisor maintained that women were more satisfactory than men for such precise, detailed work as physical testing and spectrograph and quantometer analysis. A chemical research laboratory representative also found women especially competent in microanalytical work, in which precise hand skills combined with technical interests are important, and in research supporting fields involving instrumental measurement and characterization of materials. In the particular areas

Employment of Women in Technician Occupations (Continued)

of technical work in which such characteristics as competence in mathematics and statistics, precision, patience, and delicate hand skills are especially important, many employers claim women are often more satisfactory than men. In addition, some personnel directors noted that they had difficulty filling jobs in which a combination of technical knowledge and typing were needed, and that a woman with technical training who could also type would be very readily hired for such technician jobs."

2. PRESENT AND POTENTIAL NEEDS FOR TECHNICAL WORKERS

Technological change is bringing into primary focus the emerging group of occupations in American industry coming to be known as "technicians." As outlined in the previous chapter, the pay roll jobs in this group are of great variety, in types of duties and in the scope and level of abilities needed. The impact of technological change on this group has been marked within the past ten years, and predictions indicate that the growth in numbers needed in the years ahead will be proportionately greater than for any other occupational group. Two aspects of this growth are worthy of mention: a) the emergence of distinctly new jobs of technician character, and b) the trend toward using technicians to perform many jobs previously done by engineers.

Among the many technological developments which have occurred recently, four areas may be mentioned which are providing increasing numbers of new types of technician jobs. These are automation, aero-space developments, nuclear energy, and data processing. The broad field of technician occupations includes jobs in research, development, manufacture, sales, installation, operation, and maintenance. The newly developing areas are opening up many new jobs in all these fields of technician activity. The older fields of industrial activity are also changing, with increased emphasis on more highly developed technology.

In the early days of engineering, much of the drafting, design, laboratory testing, surveying, and work of like nature, was done by the engineer. This is still true to some extent. But the engineer is now moving into work of a highly scientific character, and it is not economical to use his time and energy for tasks that can be performed by technicians whose training can be provided in a relatively shorter period. The great need for engineers has accelerated this shift of tasks, and is creating new opportunities for employment of workers on the technician level.

The changing geography of American industry has widened the geographic distribution of technician occupations, as reported by Wolfbein. (69). In the period 1947 to 1960 the growth of non-agricultural employment in continental United States has increased 23.9 percent. Decreases occurred in Rhode Island and West Virginia; increases of less than 10 percent took place in Maine, Vermont, Pennsylvania, and Illinois. Increases of over 40 percent occurred in Arizona, California, Colorado, Florida, Nevada, New Mexico, Texas and Utah. Three states - California, Florida, and Texas -- in 1960 had 16 percent of the total non-agricultural employment in the United States, and some 29 percent of the total increased number of jobs

since 1947. As a whole, the States are becoming more nearly alike in their proportions of non-agricultural population. It was indicated also that we may see changes in the pattern of migration from farm to city toward movement within the State rather than to outside the State. As an outgrowth of these trends, the needs for technicians are tending to be more widely distributed throughout the States, and programs for the training of technicians will need to give due consideration to the placement market for their graduates within the State as well as outside it.

Increasing attention is being given to occupational surveys to determine the numbers of technicians needed and the tasks performed by these technicians. State Employment Security Commissions, State and local educational agencies, and the United States Department of Labor have made such surveys within the past four years. Some of these surveys dealt with needs in local areas. Others were State-wide or national in scope. Some variations occur in the occupational scope covered, and in the definitions used in defining what is meant by a technician occupation. Some of the surveys confined their study to the needs for "engineering technicians". Others reached a wider scope to include occupations which might be classified as "industrial technicians" and "technical specialists." Some selected surveys are reviewed in the pages which follow.

Surveys Made by State Employment Security Commissions

The Arizona State Employment Service Survey (3), made in 1959, reported on needs for technical workers needed to support professional workers, including draftsmen, electronic technicians, medical and X-ray technicians, and surveyors. The findings are as follows:

	Estimated Employment 1959		Estimated Employment 1969	
	Number	Percent women	Number	Percent women
Draftsmen	1150	7.3%	2950	12.1%
Electronic technicians	1100	2.6	3350	6.0
Medical and X-ray technicians	950	42.5	1750	46.8
Surveyors	450		750	

The projected increase in the proportion of women in technician occupations is in keeping with trends observed also in other surveys.

The New York State Department of Labor Survey (42), made in 1960, reported that 107,000 technician jobs will need to be filled between 1957 and 1970. Industrial expansion will account for 62,000 of these jobs, 20,000 to fill openings caused by death and retirement, and 25,000 to fill vacancies caused by shifts of technicians to other occupations, including those who prepared themselves for engineering positions through part-time training. Data reported for the labor force in 1957 and estimate for 1970, together with estimated numbers of engineers and technicians are as follows:

	1957	1970	Percentage increase
Total labor force	6,962,000	8,417,000(est.)	21%
Estimated numbers:			
Technicians	97,800	159,300	62.9%
Engineers	94,400	164,800	74.6

The breakdown of technician occupations, with estimated numbers, is reported as follows:

	1957	1970	Percentage Increase
Engineering & physical science technicians	28,600	46,400	62.2%
Medical and dental technicians	12,100	23,000	90.1
Electronic technicians	18,000	27,800	54.4
Tool designers	2,500	3,900	56.0
Designers, except tool	11,100	13,600	22.5
Draftsmen	23,200	41,200	77.6
Surveyors	2,300	3,400	47.8
Total	97,800	159,300	62.9%

It is interesting to note the numbers of medical and dental technicians projected for 1970 and the rapid rate of growth. An extensive survey of technicians in New York State is currently under way by the Department.

The North Carolina Employment Security Commission survey (18) of technician and selected skilled crafts occupations was carried out during 1961, and the final report is now being completed. The survey was State-wide and was made through interviews with some 1200 establishments, which employed 364,000 workers, approximately 60 percent of the total employment in these industries. Data were projected to cover the total employment. In 1961 the number of technical workers employed (including some technical specialists as well as industrial and engineering technicians) numbered 14,000. Estimates for 1966, made by employers for each occupation studied, indicate technical worker jobs at 21,000, a gain of approximately 50 percent in five years. During this period industry expects to train some 1500 of the new workers needed, and some 6800 workers will need to be trained in out-plant educational institutions.

The Utah Department of Employment Security Survey (67) was made in 1958, and secured information from 879 employers representing 43 percent of the State's non-agricultural labor force. The data were obtained by questionnaires. The report shows that some 2400 technicians were employed in 1958, and that the estimated number for 1963 was about 3900 positions, an increase of approximately 60 percent in the five years. Data are shown for chemists assistants, draftsmen, electronics technicians, engineering aides, laboratory assistants, scientific aides, testing technicians, estimators, inspectors, layout men, production planners, and others.

Occupational Surveys Made by Educational Institutions

In addition to the surveys made by Departments of Employment Security, reported in part in the previous section, many surveys have recently been made by State and local educational authorities. Here are brief reports on some of these surveys;

The Engineering Extension Service, Texas A & M College System, made a survey of technical occupations in 1959, (51), using the personal interview method. The survey covered 218 selected firms in the principal employment areas of Texas, employing 183,000 workers. The survey report contains data on detailed work activities of technicians, and employers' preferences concerning age, sex, and educational background of technicians. The data on employment were classified in the groups shown below:

	Number employed 1959	Estimated employed 1964
Engineering technicians	3,874	5,062
Maintenance technicians	2,999	3,659
Mechanical technicians	1,777	2,136
Production technicians	5,126	5,913
Laboratory technicians	1,631	1,919
Electronic technicians	1,358	2,482
Electrical technicians	1,112	1,363
	17,877	22,534

The growth in numbers of technicians over the five year period is 26 per cent. The report indicates that while there is no apparent shortage of technicians in large industries, there is an undiminishing cry for assistance in the smaller service companies, not included in the survey.

The Florida State Education Department survey (24), made in 1959, covered 585 enterprises. Most of the data were gathered by mailed questionnaires, which were supplemented by personal interviews with approximately 8 percent of the organizations. Data on present employment and current openings reported in the survey are as follows:

	Number employed	Current openings
Aeronautical technicians -----	567	365
Agricultural technicians -----	122	20
Chemical technicians ---------	214	65
Construction technicians------	844	277
Drafting technicians ---------	1,585	525
Electronic technicians -------	1,051	181
Electronic technicians -------	4,390	1,102
Mechanical technicians -------	1,256	381
Metallurgical technicians ----	32	25
Other technicians ------------	1,926	606

As noted in the above data, electronic technicians rank high in Florida industry.

The Kansas State Board of Education made a study (29) of the training needs of highly skilled technicians in 23 selected manufacturing and processing firms in Kansas in 1959. The data covered 42 job titles and showed 830 technicians employed in 1959. The numbers estimated as needed to be trained in the five years following the survey was 1,088, of which 820 were in the category of electronics technicians.

The Kansas City Board of Education survey (30), made in 1958, covered 480 firms employing 125,000 workers, a 64 percent sample of the manufacturing industries and 39 percent sample of the total workers in the area. The data were gathered by interviews. The survey covered both skilled and technical occupations. Data found on selected technician occupations are as follows:

	Number employed 1958	Estimated number needed in next five years
Chemical laboratory technician	567	383
Civil engineering aide	310	270
Draftsman	2,783	2,216
Electrical engineering aide	304	149
Electronic technician	326	378
Estimator, building	376	227
Industrial engineering aide	195	55
Mechanical engineering aide	262	276
Metallurgical technician	101	96
Physical laboratory technician	296	169
	5,520	4,219 (average of 844 per year)

The Los Angeles City School District made a survey of the education and training for technical occupations in the San Fernando Valley in 1961 (12). This was a survey of an area of rapid population growth, more than 100 per cent between 1950 and 1960. The survey covered 837 industries with a current employment of 114,000 workers. The data were obtained by questionnaires, supplemented by personal contact with 384 of the industries. The report showed the following current and estimated employment of technicians in the industrial organizations surveyed:

	Number	Percent of total work force
1960	13,588	11.9 %
1965 (est.)	32,648	20.1
1970 (est.)	57,770	26.5

It was estimated that the total industrial employment in the area by 1970 will be 302,000 persons, distributed as follows:

	Number	Percent of total
Engineers	45,904	15.2%
Technicians	80,030	26.5
Skilled workers	70,668	23.4
Unskilled	38,354	12.7
Other	67,044	22.2
	302,000	100.0%

It is interesting to note that the estimated numbers of technicians in 1970 exceed those for the skilled trades, and that they represent more than one-quarter of the total industrial work force. The numbers of technicians needed during the ten-year period 1960-1970 to fill the openings in selected fields are shown below:

Technician field	Number needed
Design	4,375
Flectrical-electronics	30,910
Mathematical	3,340
Mechanical	13,580
Applied science	5,700
Staff, administration, service	6,150

The Middlesex County (N.J.) Board of Education of Vocational Schools made a survey in 1959 (7) of the need for vocational-technical education in the County. Data were reported as follows:

Technician group	Survey sample (per cent of total employed in the group)	Number employed in industries surveyed - 1959	Estimated total employment in county	Estimated annual new entrants
Laboratory technicians	80%	1,096	1,370	84
Electronics technicians	80	465	580	94
Draftsmen	70	340	485	29
Instrument mechanics and technicians	60	255	425	45
Miscellaneous technicians	50	215	430	16
County total		2,371	3,290	268

The report indicates that Middlesex County has many industrial and research laboratories in the chemical, pharmaceutical, primary metals, and petroleum refining industries, reflected in the high proportion of the total numbers of technicians found in the laboratory technician group in the above table.

The Syracuse (N.Y.) Board of Education survey (50), made in 1960, covered 33 industrial establishments employing 41,000 workers, 67 percent of the industrial employees in Onondaga County. Data on employment of three groups of technicians are as follows:

Technician group	Employment 1954	Employment 1959	Employment 1962 (est.)
Electrical technicians	931	1,461	1,809
Mechanical technicians	731	1,066	1,224
Chemical technicians	89	216	269
Total	1,751	2,743	3,302

The estimated annual demand to fill new positions for 1959 employment was:

Electrical technicians - 116; Mechanical technicians - 53; Chemical technicians - 18; a total of 187 per year.

Employment of Technicians in the Atomic Energy Field

The Bureau of Labor Statistics study of employment in the atomic energy field (62), made in 1960, covered 158 establishments which held prime contracts with the Atomic Energy Commission. The total employment in the atomic energy field was estimated at 200,000, and the survey covered some 126,000 workers. The employment of technicians is shown as follows:

	January 1960	Estimated January 1961	Percent change
Draftsmen	2,660	2,690	1.1
Engineering and physical science:			
Electronics technicians	2,036	2,256	10.8
Instrument technicians	627	683	8.9
Other	6,100	6,352	4.1
Health physics technicians	720	771	7.1
Medical, agricultural and biological technicians	569	607	6.7
Other technicians	1,900	2,034	7.1
	14,612	15,393	5.3

In addition to the workers reported under the classification of "technician", the survey also found 1,160 designers, 195 technical writers, and 2,389 "other technical personnel," which may have included workers on the technician level. The report shows the distribution of technicians among 10 segments of the atomic energy field: AEC research facilities, defense production facilities, reactor manufacture, production of feed materials and enriched uranium, construction of nuclear facilities, private research laboratories, production of special materials, uranium mining, fuel element fabrication, and power reactor operation.

The emergence of new types of technician jobs - such as health physics technician - is worthy of notice.

Studies of Technician Occupations Made Prior to 1950

Two of the older studies in the field of technician training are briefly summarized here because they pointed out the importance of the technician in American industry, and have influenced somewhat the later studies. These are the "Study of Technical Institutes reported in 1931 by the Society for the Promotion of Engineering Education," and "Vocational-Technical Training for Industrial Occupations" reported in 1944 by the U.S. Office of Education. Both of these studies explored the needs of industry for technicians.

The S.P.E.E. study (49) summarized small studies made in New Jersey and California, a study by the National Industrial Conference Board of five industries, and made a spot check among a few industries selected on a

nation-wide basis. The approach was from the standpoint of the place of the technical institute graduate in industry, rather than from analysis of specific technician employment in the work force. The findings are summarized in the following quotation from the report:

> "Manufacturing industries quite consistently estimate their normal requirements of four-year engineering graduates at from 2.2 to 3.0 per cent of their total forces. In a few industries this ratio is being approached, while in others great deficits exist. Taken as a whole, this potential demand is perhaps one-third supplied. The same industries estimate the desirable quota of employees having approximately two years of training above the secondary level at from 6.0 to 8.3 per cent of their total forces. At present this potential demand is not more than one-fiftieth supplied, and an annual output of from 25,000 to 30,000 graduates a year from technical institutes could be absorbed to great advantage. The estimates of relative needs made by public utility and transportation companies are of the same order, and there are grounds for believing that they fairly represent the mineral industries as well."

The study indicates that industry as a whole could absorb 40,000 to 50,000 technical institute graduates. The data were gathered largely in 1929, at the peak of the boom of the 1920's, and may reflect the optimism of that period. The study makes use of a ratio between the numbers of technicians and the numbers of engineers employed, and found that in four separate studies conducted at different periods under different circumstances in different industries the ratios between technicians and engineers were very much alike -- from 2.6 to 1, to 2.8 to 1. This procedure has been utilized in later studies, including the latest survey made by the Bureau of Labor Statistics for the National Science Foundation.

The U.S. Office of Education study (22), reported in 1944, was made by the Division of Vocational Education, and was conducted with the assistance of State Boards for Vocational Education in 23 States. The stated objective of the study was to point out typical needs in selected industries, rather than to present an exhaustive analysis of the needs in industry. Twenty three industries were selected for study. The States chosen to assist in making the survey were generally those prominently associated with the industry. The industries studied and the States where the data were gathered are as follows:

Industry	States Participating in the Study
Air Transportation ----	National basis - 7 airlines
Aircraft Manufacturing ---	California - Maryland
Automobile Manufacturing ---	Michigan
Building Construction ----	New York
Communications Equipment Manufacturing -----	New Jersey - New York
Electric Power Production and Distribution	Oregon

Industry	States Participating in the Study
Electrical Equipment Manufacturing---	Massachusetts
Hydroelectric Development ---	Tennessee (TVA)
Industrial Chemistry ----	Delaware - Missouri
Industrial Electronics ---	New York
Iron and Steel Production ---	Pennsylvania
Lumbering and Wood Processing ---	Washington
Machine Tool Manufacturing ----	Vermont
Metal Mining ---	Colorado
Metal Products Manufacturing ---	Connecticut
Oil Refining ---	Indiana
Petroleum and Butadiene Production ---	Texas
Pulp and Paper Manufacturing -----	Maine
Rail Transportation -------	Alabama - Utah
Shipbuilding -------------	Maine
Telegraph and Telephone Communications ------------	Illinois
Textile and Garment Manufacturing ---	North Carolina - New York

Data were gathered on several hundred payroll jobs of technician type, which are listed by industries. Detailed job descriptions are given for many of these jobs. Suggested job classifications are:

1) Engineering aides and science aides, such as drafting specialists and laboratory technicians, requiring a year or two of preemployment training.

2) Technical specialists or limited technicians, such as certain instrument repair men and certain types of inspectors, who can be trained in relatively short preemployment or preproduction courses.

3) Technical production and maintenance supervisors, who must have a background of industrial or trade experience, plus supplementary technical and foremanship training.

4) Semitechnical men, such as salesmen, whose basic training is in the field of distributive education, but who must have some technical knowledge of the things they sell; and such as factory accountants, whose basic training may be in the field of accounting, but who must have some technical knowledge of the plant and its products.

Estimates were made in 16 country-wide industries of the numbers of technicians as compared with the number of engineers, using a ratio similar to that of the S.P.E.E. Study. The ratio varied from 20.0 to 1 in the lumbering and wood processing industry, to 2.0 to 1 in hydroelectric development. The average ratio found was 5.2 technicians per engineer. A separate study made in New Jersey in 1943, involving 99 industrial concerns employing 970,000 persons, was reported to show 4.4 technicians per engineer.

This is the first large study reporting payroll titles of technician jobs and detailed job descriptions. The definition of a technician was not defined with any precision when the study was made, and consequently great variations occur in the jobs classified as such. Many are probably included which other surveys have considered as in the skilled crafts category. Perhaps the greatest value of the study is in portraying the large scope of the technician occupations, their diversity, and their importance in industry.

American Society of Engineering Education Survey of Technical Institute Education

As a part of the broad survey of the technical institute in America in 1957-58, made under the auspices of the Technical Institute Division of the American Society for Engineering Education (26), data were gathered from approximately 100 companies scattered over the United States, concerning their employment of engineering technicians. From the findings of this survey, Henninger reports present and desired ratios of engineering technicians to engineers as follows:

	Median ratio of engineering technicians to engineers
Present ratios 1957 (100 companies)	.8 to 1
Present ratios - 1957 (50 companies)	.7 to 1
Desired ratios - 1957 (50 companies)	1.0 to 1
Desired ratios - 1962 (50 companies)	1.3 to 1
Desired ratios - 1967 (50 companies)	1.9 to 1

He concludes that there was a current market in 1957 for some 30 percent more engineering technicians than were available, and that within the following decade employers would like to hire more than twice as many new engineering technicians as new graduate engineers. It should be kept in mind that the above data refer to engineering technicians with background equivalent to graduation from a technical institute type of curriculum as accredited by the Engineer's Council for Professional Development, and may not include the many technical occupations outside this scope.

Recent Nation-wide Studies of Scientific and Technical Personnel

Two studies recently made by the Bureau of Labor Statistics for the National Science Foundation provide extensive data on present and projected employment of technicians. One deals with employment of scientific and technical personnel in industry in 1960. The other is a methodological study dealing with the long-range demand, with predictions for employment in 1970.

The National Science Foundation study of scientific and technical personnel in 1960 (41), prepared by the BLS, surveyed employment on a national basis. Questionnaires were sent in May 1960, to 10,500 companies which employed 16 million workers in 1956. This was about 39 percent of all private nonagricultural employment in that year covered by OASI. Although most of the study dealt with engineers and scientists, a significant portion pertained to the employment of technicians. For the purpose of the survey, technicians were defined as follows:

> "All persons engaged in work requiring knowledge of physical, life, engineering, and mathematical sciences comparable to knowledge acquired through technical institute, junior college, or other formal post-high school training, or through equivalent on-the-job training or experience."

The work of the technician was explained as either assisting the scientist or engineer directly, or performing some of the tasks that otherwise would be done by him.

The report showed 594,000 technicians in American industry in January 1960, an increase of approximately 8 percent over the comparable January 1959 figure. The ratio of technicians to scientists and engineers also increased over this period. Technicians were found throughout industry, but about 44 percent were employed in four industrial groups -- electrical equipment, machinery, aircraft manufacturing industries, and engineering and architectural services. Some 27 percent of all technicians were primarily engaged in research and development work. Between January 1959 and January 1960 the rate of growth for draftsmen was 7.6 percent; for engineering and physical science technicians 13.7 per cent; and for medical, agricultural and biological technicians .2 percent. Nearly all industries shared in the growth of technicians in this period. Table III shows the numbers of technicians employed, by industries, in January 1959 and January 1960, and percent change.

The report comments on the growth in employment in the construction field between 1959 and 1960 as possibly due to seasonal factors, and that data collected in January may not reflect year-to-year changes.

The report shows the distribution of the 593,600 technicians employed in 1960 as follows: Draftsmen - 210,000; Engineering and physical science technicians - 284,600; Medical, agricultural, and biological technicians - 16,100; and other technicians - 82,900. It provides a table showing these groups of technicians distributed by industries.

Table IV shows the employment of scientists and engineers, and of technicians, in January 1960, and the ratios between these groups, by industries.

TABLE III. TECHNICIANS, BY INDUSTRY, JANUARY 1959 and JANUARY 1960

Industry	Number Jan. 1959	Jan. 1960	Percent change
Food and kindred products	5,200	8,100	53.9
Textile mill products and apparel	3,900	4,700	22.1
Paper and allied products	6,100	6,500	5.4
Chemicals and allied products	34,400	39,500	14.9
Petroleum products and extraction	18,200	18,100	- .3
Stone, clay, and glass products	4,500	5,000	9.8
Primary metal industries	16,900	17,900	6.4
Fabricated metal products and ordnance	34,200	37,800	10.6
Machinery (except electrical)	65,400	72,100	10.3
Electrical equipment	67,400	79,200	17.5
Motor vehicles and equipment	25,300	24,500	-3.2
Aircraft and parts	52,500	46,800	-10.9
Professional and scientific instruments	19,600	21,300	9.0
Other manufacturing industries	26,900	28,000	4.0
Construction	21,200	26,800	26.5
Transportation and other public utilities	25,100	27,000	7.7
Engineering and architectural services	62,300	63,500	1.9
Other nonmanufacturing industries	60,300	66,800	10.8
All industries	549,400	593,600	8.1

TABLE IV. SCIENTISTS AND ENGINEERS, TECHNICIANS, AND RATIO OF TECHNICIANS TO SCIENTISTS AND ENGINEERS, BY INDUSTRY, JANUARY 1960

Industry	Scientists and engineers	Technicians	Ratio of technicians to scientists & engineers
Food and kindred products	9,900	8,100	.81
Textile mill products and apparel	5,800	4,700	.82
Paper and allied products	10,500	6,500	.62
Chemicals and allied products	90,700	39,500	.44
Petroleum products and extraction	48,600	18,100	.37
Stone, clay, and glass products	10,200	5,000	.49
Primary metal industries	35,100	17,900	.51
Fabricated metal products and ordnance	38,100	37,800	.99
Machinery (except electrical)	71,400	72,100	1.01
Electrical equipment	[illegible],400	79,200	.78
Motor vehicles and equipment	35,400	24,500	.69
Aircraft and parts	101,500	46,800	.46
Professional and scientific instruments	26,300	21,300	.81
Other manufacturing industries	22,700	28,000	1.23
Construction	45,100	26,800	.59
Transportation and other public utilities	36,700	27,000	.74
Engineering and architectural services	56,900	63,500	1.12
Other nonmanufacturing industries	66,500	66,800	1.00
All industries	812,700	593,600	.73

Approximately 80 percent of the total scientists and engineers in Table IV were reported as engineers, hence in comparing ratios of technicians to engineers as shown in other studies, this factor must be considered.

The difficulty of defining the technician, and the various interpretations used in different surveys, makes comparisons of data somewhat hazardous. The definition used in the above survey may have excluded some workers who might be classified in the broad category of technicians, if one includes "industrial technicians" and "technical specialists." But the data show that technicians occupy a substantial place in the industries of America.

Perhaps the most significant study from the standpoint of planning the future of technician training is that entitled "The Long-Range Demand for Scientific and Technical Personnel" prepared by the Bureau of Labor Statistics for the National Science Foundation (40). It was a study undertaken to develop a systematic methodology for the long-range projection of demand for scientific and technical personnel, through separate analyses and projections for each segment of the economy. Data from previous BLS studies made in 1959 and earlier were projected to provide estimates of the needs in 1970. In addition to employment projections for scientists and engineers as a group, separate 1970 employment figures were derived for engineers and for a number of scientific occupations, with the same industry breakdown as in the overall figures. Similar projections were made for technicians.

The projections were made by determining the ratios of engineering and scientific employment to total employment from studies made for 1954, 1957, 1958, and 1959 for most sectors of the economy, and using the trends shown in the ratios as the basis for the 1970 projections. The projections for total employment had been developed by the Bureau of Labor Statistics as part of a major study of the country's manpower needs and resources. The report provides detailed description of the methodology used.

Projections for the employment of technicians in 1970 were made by using the ratio of technicians to engineers and scientists (modified slightly in the case of the chemical industry) and applying these ratios to the projected employment of scientists and engineers for 1970. The projected employment of technicians in 1970 in industry is approximately 1,036,000, shown in Table V broken down by industries. The survey also provided data on scientists and engineers employed in Federal, State and local government, and in manufacturing establishments which came into being between 1956 and 1959, which were not included in Table V.

TABLE V. EMPLOYMENT OF TECHNICIANS IN SELECTED INDUSTRIES-1959 AND PROJECTED 1970

	1959			Projected 1970	
	Scientists and engineers	Technicians	Ratio of techni-cians to scientists and engineers	Scientists and engineers	Technicians
ining ------------------------	30,500	8,600	0.28	79,500	22,400
onstruction ------------------	53,700	21,200	.39	110,600	43,600
anufacturing:					
Food and kindred products----	10,200	5,200	.51	13,400	6,900
Textile mill products and apparel	5,400	3,900	.72	6,500	4,700
Lumber and furniture---------	2,900	2,500	.85	3,900	3,300
Paper and allied products-----	9,700	6,100	.63	21,300	13,500
Chemical and allied products----	83,100	34,400	.41	151,500	69,700 *
Petroleum refining and products of petroleum and coal --------	28,000	12,400	.44	39,100	17,300
Rubber products ----------------	7,300	13,500	1.85	10,500	19,300
Stone, clay, and glass products--	9,200	4,500	.49	15,000	7,400
Primary metal products-----------	33,200	16,900	.51	66,300	33,600
Fabricated metal products and ordnance ----------------------	34,700	34,200	.98	78,500	77,300
Machinery ---------------------	67,400	65,400	.97	125,500	121,800
Electrical equipment-----------	92,700	67,400	.73	211,000	153,500
Transportation equipment-------	130,800	81,300	.62	292,400	181,600
Professional and scientific instruments-----------------	23,700	19,600	.83	49,300	40,700
Miscellaneous manufacturing ---	7,700	7,400	.96	10,300	9,900
ransportation, communication, and public utilities--------	59,500	53,300	.90	84,800	76,000
ngineering and architectural services -----------------	56,100	62,300	1.11	72,100	80,000
edical and dental laboratories---	1,000	6,400	6.47	1,300	8,500
iscellaneous business services---	7,000	4,400	.63	12,300	7,800
ther nonmanufacturing-----------	26,300	18,500	.70	52,700	37,000
	780,100	549,400		1,507,700	1,036,000

*Calculated at a revised ratio of .46

No estimates were provided in the survey for the numbers of technicians employed in Federal, State, and local government, and in the manufacturing establishments which came into being between 1956 and 1959. The projected employment of technicians shown by industry in Table V was made by using a ratio of technicians to scientists and engineers for each industry. Such ratios for employment in government and in the new companies were not provided in the report. To get an estimate of the number of technicians needed in these fields, the data on employment of scientists and engineers shown in these fields were used as a basis, and ratios applied which appeared to be reasonable for each group. The data on employment of scientists and engineers, and the projected data on technicians are shown in Table VI.

TABLE VI. EMPLOYMENT OF TECHNICIANS IN GOVERNMENT AND NEW INDUSTRIES 1959 and 1970

	1959			Projected 1970	
	Scientists and Engineers	Technicians	Ratio of technicians to scientists & engineers	Scientists and engineers	Technicians
Government:					
Federal	101,400	69,000	.68*	164,300	111,700
State	39,400	26,800	.68*	73,100	49,700
Local	30,000	20,400	.68**	49,600	33,700
New companies	22,000	15,200	.69**	45,700	31,500
Total	192,800	131,400		332,700	226,600

(*) Average ratio for manufacturing industries
(**) Average ratio for all industries

Estimated total needs for technicians

The combined estimates for numbers of technicians to be employed in 1970, from Tables V and VI, show a total of 1,262,600 in the occupational fields covered in the National Science Foundation surveys. When compared with the 680,800 technicians employed in 1959 in these fields, the increase is seen to be 581,800 technicians in the 11-year period, or an average of 52,900 new jobs per year. In estimating the numbers needed per year due to deaths and retirements the writer used an estimated annual replacement rate of 1.55 percent, found in a recent study of technical workers in North Carolina. This gives an average annual number of 15,000 technicians needed as replacements. The total annual demands for technicians -- new jobs and replacements -- are thus estimated at 67,800 new workers, based upon the coverage and projections of the NSF study.

The establishments included in the NSF survey were primarily those liable for OASI taxes, and excluded small establishments in wholesale and retail trade, miscellaneous service industries, construction, and other fields. These small establishments usually employ few engineers and scientists, but employ technicians.

The projection of numbers of technicians needed in 1970 in the NSF study was based on the ratio between the number of technicians and the number of engineers and scientists as found in 1959, which showed an average ratio of approximately .7 between these groups. The special studies made in the chemical and electrical fields indicated an estimated 11 percent increase in the ratio for 1970 in the chemical industry, and little change in the electrical equipment industry.

The ratio of .7 to 1 between the numbers of technicians and of engineers and scientists, as found in the NSF survey, appears low to many industrialists as an optimum ratio. Frequent statements are made expressing a desirable ratio of 3 to 1. Soviet Russia now employs technicians in a ratio of 2.5 to 1 as compared with engineers (13), with the ratios for light industries running as high as 8 to 1. Henninger draws the conclusion that within the next decade employers would like to hire more than twice as many new engineering technicians as new graduate engineers (26). Comments of industrialists concerning increase in the ratio often are coupled with a statement to the effect that a limiting factor in achieving the increase desired is inability to find qualified technicians with proper education and experience. Estimates of numbers of technicians needed in such rapidly expanding fields as data processing run into very large numbers.

When one considers the many factors involved in arriving at estimated total needs for technical workers, such as the varied interpretation of the technician occupation, the omissions in the surveys of segments of occupational life where technicians are employed, the great potential demands for technicians that may lie in new technological developments, the efforts of industry to relieve the engineering shortage through the use of more technicians, the numbers of technicians who enter engineering jobs, and the like, one reaches the opinion that the annual needs are far beyond those indicated above from data obtained in the NSF survey. The resulting conclusion of the writer is that the indicated needs call for a ratio of at least 2 to 1 between technicians and engineers, or a total of some 200,000 technicians needed annually in the years immediately ahead.

3. HOW TECHNICIANS GET THEIR TRAINING

The paths to technician occupations are many and varied. Many technicians have acquired their technical skills by learning on the job, supplementing their work experience with self study, correspondence courses, and evening classes. Some technician occupations require understanding of the skilled crafts, and many of these workers have come up through the ranks of the skilled crafts, and many of these workers have come up through the ranks of the skilled trades. In certain fields, such as electronics, many technicians have been trained in schools operated by the Armed Forces. Some have started engineering courses and have dropped out, getting into technician work. Many with engineering degrees now occupy technician positions, on their way up to engineering work, or as somewhat permanent jobs. Increasing numbers of technicians are now coming from schools with programs specifically designed for technician training, found in technical institutes, community colleges, vocational-technical schools, and, to a limited degree, from technical high schools. Training programs within industry provide considerable numbers of technicians. As noted from Figure 4, most of the training opportunities for technicians lie beyond the high school.

Quantitative data on the sources of technicians are not readily available in sufficient quantity to permit valid estimates of the relative contributions from the various sources. Some indications, however, may be observed in some of the recent surveys.

In the survey made by the California State Education Department, of electronics and chemical technicians (9), data were obtained from 197 technicians employed in electronics firms and from 81 technicians employed in the chemical industry, as shown in Table VII.

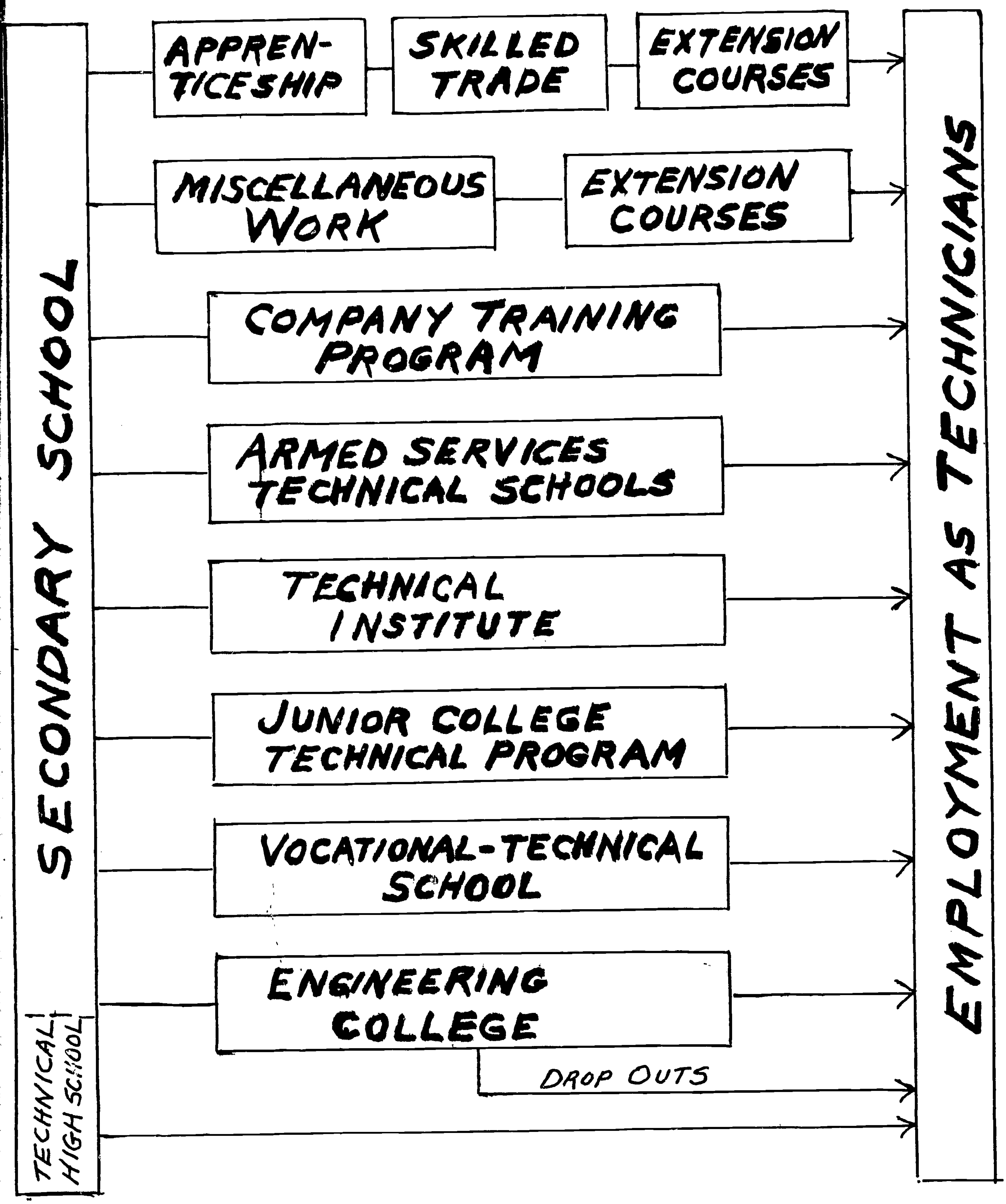


Figure 4. Paths to Technician Jobs

TABLE VII. SOURCES OF TRAINING OF ELECTRONICS AND CHEMICAL TECHNICIANS (278 technicians in San Francisco Bay area)

Source of training	Percentage of Total Sources	
	Electronics	Chemical
School	21.8%	22.2%
Military service	21.3	4.9
On-the-job	10.2	38.3
School and service	15.7	2.5
School and job	10.2	18.5
Service and job	9.6	6.2
School, service, job	8.6	1.2
None reported	2.5	6.2
	100.0%	100.0%

Although the numbers of technicians covered in the survey are not large, the data give some idea of the range of training sources for technicians in these industries in the San Francisco Bay area.

The Kansas City survey (30) reported the chief sources of workers for selected technician occupations as shown in Table VIII.

TABLE VIII. CHIEF SOURCES OF SELECTED TECHNICAL WORKERS IN THE KANSAS CITY METROPOLITAN AREA (6,000 TECHNICIANS).

Technician occupation (All figures are given in percent)	Apprenticeship	On-the-job Training	Trained in Armed Forces	Institutes other than colleges	Upgraded	Colleges	Hire only experienced workers
Chemical laboratory technician	--	5.1	--	37.9	36.6	7.9	12.5
Civil engineering aide	--	--	--	5.8	3.5	34.9	55.8
Draftsman	1.3	7.6	--	31.0	28.0	3.8	28.4
Electrical engineering aide	--	2.3	11.4	63.6	1.1	19.3	2.3
Electronic-radio-TV technician	0.8	10.0	28.5	32.3	23.8	----	4.6
Estimator, building	--	0.8	--	47.9	37.2	2.5	11.6
Industrial engineering aide	2.2	22.3	--	6.5	35.3	16.5	17.3
Mechanical engineering aide	--	2.2	--	7.2	25.2	43.2	22.3
Metallurgical technician	--	46.8	--	6.4	30.3	6.4	10.1
Medical and dental assistants	17.6	23.5	--	55.3	--	1.2	2.4
Physical laboratory technician	--	1.7	--	2.3	51.8	1.7	42.5

The preliminary report of the survey made by the North Carolina Employment Security Commission (18) provided information on the expectations of industrial concerns with respect to numbers of technicians they hoped to supply through in-plant training programs to meet their needs in 1966. The total needs in 1966 in 33 selected occupations which appeared to be definitely of technician type amounted to nearly 18,000 workers and the companies expected to provide 6.9 percent through in-plant training programs, with technical training for the others to be supplied by out-plant agencies through preemployment and extension programs.

The study of the mobility of electronics technicians made in 1952 by the Bureau of Labor Statistics (63), reported interviews with 1,926 electronic technicians in the metropolitan areas of Atlanta, Baltimore, Boston, Chicago, Detroit, Los Angeles, New York, and Philadelphia. A part of this survey dealt with how these technicians received their training. Technical school courses were the most important type of training among these electronic technicians. See Table IX. More than half of the technicians had attended full-time civilian technical schools, and one-third had received training in Armed Forces schools. Eighteen percent reported that they had received their training on the job. Learning in the home was a common method of acquiring skill in electronics. Many technicians attributed some of their skill to correspondence courses, home study, and amateur "ham" radio work. Most of the men who attended full-time civilian technical school took courses lasting from 12 to 24 months. Those who attended the Armed Forces technical schools usually took 6- or 12-month courses.

TABLE IX TRAINING BACKGROUNDS OF ELECTRONIC TECHNICIANS IN SELECTED TYPES OF ESTABLISHMENTS

(Percent of Respondents in Each Type of Establishment)

Type of training	Radio-TV repair	Broadcasting	Manufacture of radio-TV	Manufacture of other electronic equipment	Manufacture of aircraft	Research
IN SCHOOL:						
Civilian technical schools	56.5	62.1	72.2	45.2	45.5	50.9
Armed Forces technical school	29.9	33.3	44.3	38.6	42.5	40.8
Part-time technical school	25.8	25.1	27.9	24.4	20.4	34.7
IN THE PLANT:						
Apprenticeship	16.3	9.9	6.4	11.2	12.1	6.9
Other on-the-job training	7.2	2.0	0.0	1.5	2.3	3.4
AT HOME:						
Correspondence courses	22.4	29.1	19.0	16.2	23.5	19.7
Amateur "ham" hobby work	7.2	35.3	6.3	13.2	15.9	15.6
Other hobby work	39.1	44.7	35.4	42.1	37.1	36.7

NOTE: If a technician had undergone more than one type of training, he was counted more than once.

The preceding references to studies that provide some data on sources of technicians, although they cover a very limited number of technicians, give some insight into the relative importance of sources for different types of technicians. Military service has contributed a substantial portion of electronics technicians, but relatively little in other fields. On-the-job training and upgrading have provided many technicians. The Kansas City survey shows that many technicians of the engineering aide type had engineering college training, possibly indicating that engineers were employed in these jobs because few technicians had been available in that area who had received training of the technical institute type. As the schools specializing in the training of technicians expand in numbers and in enrollments, and become established more firmly as desirable sources of trained technicians, it is probable that higher proportions of such workers will come from this source. This will not take place over night and we must expect that technicians will be recruited from the other sources for a long time to come.

4. TECHNICAL TRAINING WITHIN INDUSTRY

Few technicians receive all their training solely through on-the-job experience. Many of them, however, have received much of it in this manner, learning from their more experienced fellow workers. Often this learning has been on an unorganized basis, with technical skills being learned from one task and another on a hit-and-miss basis. Sometimes the on-the-job training has been organized, with instruction progressing from one task to another. In some instances it has taken the form of technician apprenticeship. Practically always the on-the-job experience has been supplemented by outside study of some sort - informally at home, through correspondence courses, or through part-time attendance at evening or other out-of-hour classes in courses designed for the training of technicians. The various types of supplementary instruction are discussed at some length later in this report.

The training of technicians is following the historical pattern experienced in many other fields. The medical doctors in the early years of medicine learned his professional skills through working with another experienced practitioner. Today the formal training of doctors has reached a stage where no one is licensed unless he has completed a long training program in an approved school, and has fulfilled the requirements of an approved interneship. In engineering, formal college training is accepted as the standard method of entering the profession, but as yet this apparently is not the only way. The Long-Range Demand for Scientific and Technical Personnel study of the National Science Foundation states that during the period between 1950 and 1959 approximately 23 percent entered the engineering field without engineering degrees (40). Increasingly, technicians are entering work after completion of formal training of the technical institute type, yet at present this source is meeting only a moderate share of the needs. And it is probable that it will never attain the status of the medical college as a pre-requisite for entrance to the field. There are too many aspects of technician training that do not lend themselves to formal in-school instruction.

Some industries employ technicians in jobs of highly specialized type, found in a very few companies, which require experience in dealing with equipment which the schools cannot well provide, and for which the overall demand for workers would not justify the development of in-school programs. Some technician occupations demand thorough understanding of, or experience in, the skilled crafts, and workers in these technician jobs are often upgraded from those experienced in the crafts. Some technician jobs of maintenance type are in this category. Company policy of promotion from within has important bearing on such jobs.

Many new types of technician jobs are emerging, in this rapidly changing world of technology. Industry needs technicians now, and it cannot wait for the schools to develop training programs. For the schools are always behind in their efforts to provide trained personnel for industry. Thus the Atomic Energy Commission must at present provide much of the training needed for its technicians. Data processing manufacturers must provide training for the operation and maintenance of computers. The schools may provide some of the basic fundamental training in these fields, but until they get themselves adequately equipped with complicated and costly equipment, and adequately staffed with instructors trained in these new fields, the bulk of the specialized training will need to be done within industry itself.

In those types of technician jobs which require highly theoretical background of such types as can be efficiently and economically taught in the schools, the chances are better that the schools will more quickly increase their outputs and come closer to meeting the needs than in the case of the job types that require highly specialized processes and equipment. In the latter case the schools may provide the basic training and leave the specialized training to industry.

As yet, industry has not fully recognized the importance and the place of training of the technical institute type. This will come in time, just as engineering training is now recognized. But in the meantime industry will probably continue to provide much of its needs through on-the-job training and through organized training programs within the plants.

<u>Organized Technician Training Programs Within Industry</u>

Organized educational activities within industry and business have developed with rapid strides in recent years. The range of these activities is great, from short vestibule training programs for newly hired operatives to extended programs for the development of top level management. Clark and Sloan, authors of "Classrooms in the Factories", indicate their growing conviction that there is more education of a formal nature outside the colleges and universities of the country than within them. (12). A large percentage of the industrial workers of the nation now have access to some form of education within the plants.

It was not always so. In the early years of American industry the only form of organized instruction was apprenticeship. This was of great importance, as most of the production was done by skilled craftsmen and there were no vocational schools to provide training for artisans. As the years went by and industry grew in size of plants and in the utilization of methods of quantity production, the need arose for additional formal training. Industry had to undertake this task, for as yet no public or private secondary educational institution provided industrial training. Beginning in the 1870's corporation schools came into existence, and by 1916 it was estimated that some 60,000 boys were attending such schools (11). Contemporary with the establishment of the corporation schools was the start in development of private trade schools, followed shortly after 1900 by the first public vocational schools. These schools helped a little in supplying workers who had some industrial training, but the bulk of the training task still remained within industry.

As industry grew in size and complexity, the need arose for more workers of the technician type. Graduates of engineering schools held many of these jobs. To meet the increasing needs in this field several private technical institutes came into being, but industry itself had to provide much of the needed training.

Immediately following World War I came the upsurge in the training of foremen and supervisors, partially growing out of Charles R. Allen's application of job analysis techniques to the work of the foreman. Stimulated by the Federal Board for Vocational Education, foreman training classes developed rapidly, utilizing the conference method of teaching that has since become popular in many fields of education. Supervisory training continued to grow. During World War II, the Training-Within-Industry division of the War Manpower Commission developed the so-called "J" courses -- Job Instructor Training, Job Methods Training, and Job Relations Training. These short intensive programs have had wide application within industry, in foreign countries as well as in the United States.

The growing complexity of industry forced management to enter still another field of education, that of management and executive development. Presently this is one of the important facets of educational programs within industry.

The training of the technical staff has always been an important part of the educational task of industry. Engineering graduates enter industry each year in large numbers, and they usually come with little industrial background and meager understanding of the specific types of work they will be called upon to undertake. Industry must orient these persons to their tasks, and must supply the special technical training needed to supplement their basic education. This takes the form of planned on-the-job instruction, formal technical courses within the plant on company time or out-of-hours, subsidized attendance on special courses arranged by technical schools in the vicinity, and the like.

Technicians enter industry with varied backgrounds. Some of them come from specialized programs of technical institute type, and go into entry jobs of technical nature for which their school work has provided reasonably adequate preparation. Such persons may need at the start only a brief orientation. Others may enter industry with a more general preparation in school but with specialization in mathematics or physical science. These workers need broader orientation in the technology of the industry as well as general orientation. Some enter industry with broad technical background, such as basic engineering courses, but with little training in a specific field of technology. Such workers need to develop the technical skills peculiar to the field of work in which they are engaged. As indicated earlier, many technicians come through the ranks -- from the skilled crafts or from technical production jobs. These workers need broad training, in basic mathematics and science as well as in technology. Extended formal instruction is often needed which these workers get through home study and other means. Industry may provide encouragement to attendance at appropriate courses in nearby technical schools, or may provide such courses in the plant.

The present-day outlay for educational programs in industry totals many millions of dollars. Serbein's study of "Educational Activities of Business" (47) reports that 35 firms having 10,000 or more employees spent from $15,000 to over $15 million annually, for in-company education and training for business and industrial workers. The aircraft industry estimated its expenditures for training programs to be $34 million per year.

The professional organization directly concerned with training in industry is the American Society of Training Directors. From its inception in 1942 this organization has grown rapidly. Its activities include meetings of its affiliated chapters, an annual national convention, and a summer institute that provides training for the directors in methods of training, program planning, and administration.

The programs offered by industrial concerns for the training of technicians are many and varied. Here are a few samples of these programs.

Instrument and control manufacturers provide updating training in service and maintenance for experienced workers employed by users of the manufacturers' products. Thirty such manufacturers are listed by Elonka in the survey reported in Power for September, 1961 (15). The courses varied in length from two days to three months, and dealt with process measurement, product measurement, automatic control, data processing and computing, and control test and analysis.

International Business Machines Corporation's educational program, reported by Serbein (47), has six major areas in which it provides extensive training: sales and customer training; customer engineering; engineering; voluntary and extension education; management development; and manufacturing training. In IBM the specialist who services equipment in the field is known as a customer engineer. Special training programs are provided by the company and are given on company time. Employees eligible for the training are those who have graduated from technical schools; some have degrees in mechanical or electrical engineering. The objectives of the program are to train customer engineers to meet field needs, and to provide experienced customer engineers with training on new equipment. Excellent training facilities are provided, and full-time well-qualified instructors are employed to do the training.

The IBM program for developing assistant engineers, reported by Clark and Sloan (11), is designed to develop assistants who may assume some of the duties normally performed by engineering graduates. Enrollment is limited to laboratory technicians who hold a 2-year technical diploma or have had the equivalent in industrial or military experience. The program runs for 12 weeks, 40 hours per week. IBM also offers a wide variety of courses of technician character in its extension programs.

An interesting development in apprenticeship is the Technical Manufacturing Apprentice Program of the General Electric Company. The $3\frac{1}{2}$ year apprenticeship is designed to prepare persons for such occupations as machine repair technicians, developmental machinists, time standards personnel, production planners, and electronic equipment specialists. The program includes machine shop training supplemented by other assignments which provide practice in the technical and managerial phases of production.

The training programs within industry are so varied and so extensive that it is futile to attempt adequate description within the confines of this report. Every large industrial establishment, and many of the smaller ones, have training programs. And they appear to be growing. Clark and Sloan (11) point out that specialization beyond the compass of the technical schools has forced industry to provide additional instruction; that changing production techniques require upgrading and constant retraining on a large scale; that as the American public demands more and more technical products, prodigious numbers of competent personnel must be trained for research, production, marketing, and service activities; and that a large share of this training must be done by industry.

Industry provides the highly specialized training, but it needs the technical schools to provide the basic training, and to assist in the upgrading of workers through those aspects of technology which can be effectively taught in a school setting. In broad measure, the task is thus a cooperative one, with industry and the schools each doing the part of the total task which it is best fitted to accomplish.

5. TECHNICAL TRAINING IN THE ARMED FORCES

"The Armed Forces are probably training the most technicians in this country today. The Army, Navy, Air Force, and Marine Corps are giving advanced technical training to their personnel because military equipment has become increasingly complex. Radar, sonar, fire-control systems, and other intricate devices can be operated and maintained only by personnel with extensive technical training. the exact number of skilled and experienced military technicians who enter the civilian labor force each year is not known. Armed Forces educators have noted that many of these men are solicited for civilian jobs before they finish their military service." (46)

In the article in which the above quotation is found Rosen points out the large contribution that the Armed Forces and industry are making in helping supply the increasing needs for technical workers of semi-professional level.

The President's Committee on Education Beyond the High School comments in similar vein (47). In the 20-month period from July 1954 to March 1956, 250,000 young men were returned to civilian life with usable skills acquired in the armed services. Some 60 percent of the skills training provided by the military services has civilian application.

In its publication "A Policy for Skilled Manpower", the National Manpower Council comments at some length on the contribution made by the armed forces to the nation's industrial manpower (39). It notes that perhaps half the men entering military service receive some type of technical training, many of them receiving instruction in courses of considerable length as well as through on-the-job training. The technical training is primarily for jobs of technical specialist type, rather than that required by the all-around technician. It notes that especially in the electronics field the training is recognized by employers, and cites one study which indicated that one veteran out of five was making use of his training in civilian employment.

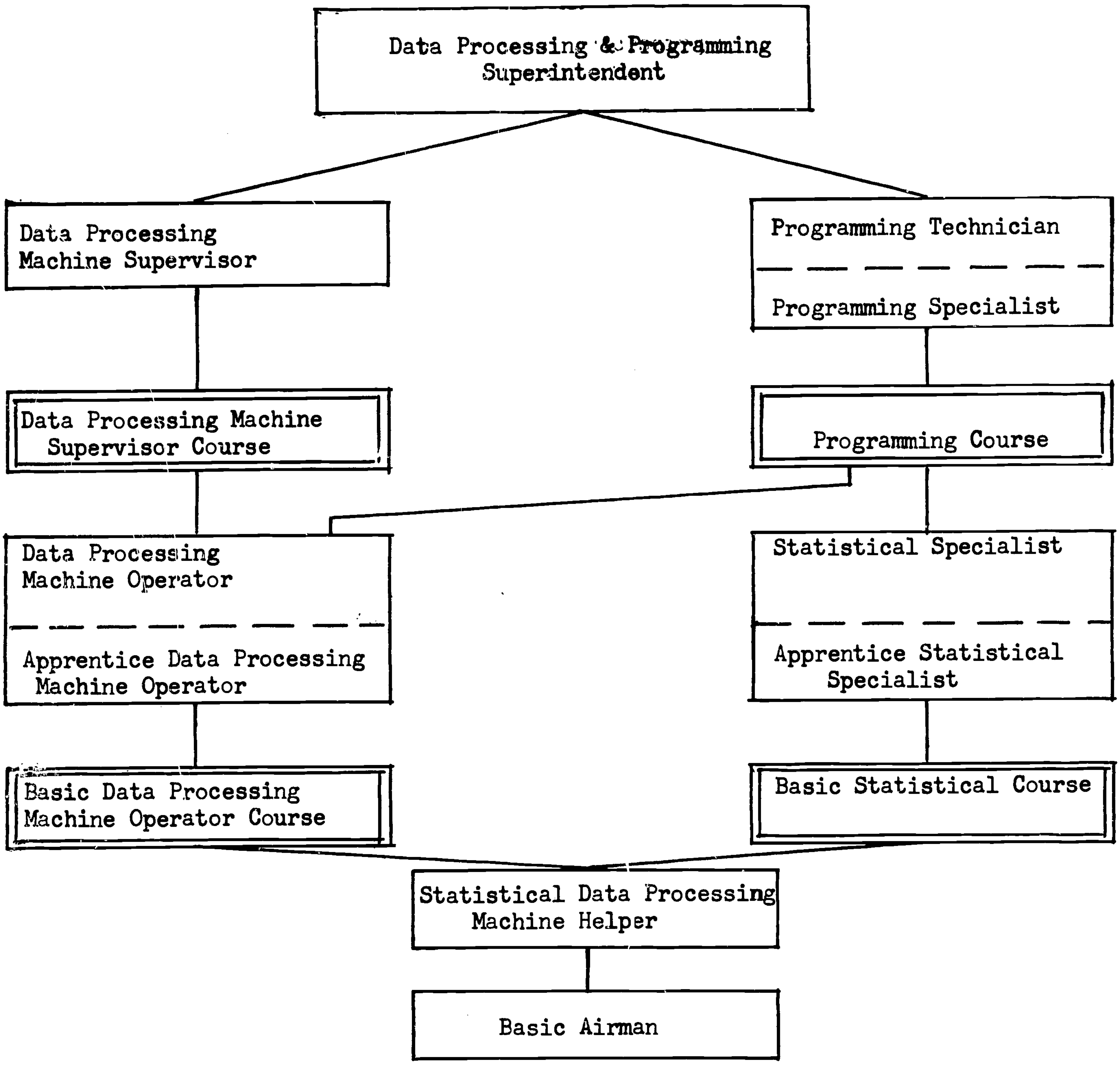


Figure 5. U.S. Air Force Data Processing Career Ladder

Adapted from Air Force Manual 35-1C, 1957

The Armed Forces use formal schools as well as on-the-job training for occupations of skilled and technical levels. In some cases the enlisted man is first given a basic course in a selected field, then put to work at a low-level job, and later is given advanced instruction. Figure 5 illustrates an Air Force career ladder in the field of data processing. In this figure one notes the use of the terms "programming specialist" and "programming technician", indicating that the worker grows from the initial specialized tasks to the broader tasks of the technician.

No data are available on the numbers of enlisted personnel trained for occupations of technical type as contrasted with those trained for the skilled occupations. The Army is reported to operate 35 different schools with over 500 different courses. In the Naval Class A,B, and C Schools more than 75 types of courses are listed, some of them with several different specific courses. In fiscal year 1961, some 51,000 persons received technical rate training in the Class A,B, and C Schools. No data are available on the proportion of these which received technical training as compared with skilled occupations. Among the courses offered in the Naval Class A, B, and C Schools are the following:

Draftsmen (engineering aides)
Electronics technicians
Fire control technicians
Opticalmen
Surveyors
Instrumentmen
Surveyors
Computer basic electronics
Planning and estimating

Many of the courses of skilled trades type include much technical content. Among the newer developments in Naval training are courses in such fields as guided missiles and nuclear power equipment.

The U.S. Air Force has many military occupations of highly specialized type, requiring some broad technical background but demanding specialized training in a relatively narrow field. Most of them would be classified as technical specialist occupations in contrast with engineering technicians type occupations although the workers are called technicians. Many of these occupations are of maintenance type, where the enlisted man must have had previous training and experience as a maintenance mechanic. The changing pattern of Air Force technical personnel due to technological change is reflected in such recent job titles as programming technician, cryogenic fluids production technician, and nuclear technician. Here are some of the many ratings listed in the Air Force as technicians:

Aerial photographic technician
Airborne radio and flight check panel operator technician
Aircraft radar maintenance technician
Aircraft loadmaster technician
Aircraft pneudraulic repair technician
Aircraft radio maintenance technician

Cartographic technician
Control tower technician
Cryogenic fluids production technician
Draftsman
Electric power production technician
Electronic fuel control repair technician
Guidance systems technician
Liquid fuels systems maintenance technician
Materials estimator technician
Medical laboratory technician
Nuclear technician
Photogrammetrist
Programming technician
Radiology technician
Surveyor-computer technician
Weather forecaster technician

Study of the above list will indicate probable usefulness of this training in civilian life after military service is completed.

The U.S. Armed Forces Institute, operated in cooperation with the University of Wisconsin, has contributed much to the technical training of military personnel (52). Its program is broad, with correspondence and group-study courses ranging from elementary school and high school courses to college and university courses. Included in the program is a large range of correspondence courses of skilled trade and technical type. In the past 20 years USAFI has formally enrolled 5 million students. Course offerings in the vocational-technical field include such areas as aviation, auto mechanics, building construction, mechanical and architectural drafting, electricity, and electronics. No data are available on the numbers enrolled in programs of semi-professional technical type, but the number is presumed to be large.

All in all, the Armed Forces are making large contributions to the civilian technical work force. The military necessity for the training given in the Armed Forces is evident. The cost runs into many millions annually, for the enlisted man must be maintained as well as trained when attending the technical training programs. Might it be possible to cut this expenditure somewhat if adequate numbers of civilian technical training programs of basic type were available so that men inducted into service might enter with more background of technical character, and thus cut the amount of basic technical training which the Armed Forces are now required to provide?

6. ENGINEERING COLLEGE GRADUATES AND DROP-OUTS AS SOURCES OF TECHNICIANS

Not too long ago much of the work done today by technicians was done by engineers. Many of these engineers performed technician tasks as a part of their duties throughout their engineering careers. To some extent this practice persists today. Some persons trained in engineering colleges find technician tasks more to their liking than the more theoretical work of engineering. The pay for technician jobs approaches that of engineers, especially in the earlier years of the person's work life. Not loo long ago the starting pay for a well-trained technician in many cases exceeded that of the beginning engineer.

The hoarding of engineering graduates by some organizations also has added many of these to the ranks of the technician, until such time as their services were needed in engineering positions. Perhaps the greatest influx of engineering graduates into technician jobs is the use of these jobs to give the potential engineer some industrial experience, which he needs before he can become effective in engineering tasks. Not all engineering graduates follow this route. Some go through a period of in-plant organized training designed for engineering graduates. Some get into jobs of engineering type immediately upon graduation. But a considerable number fill technicians jobs for a period. Usually they don't stay in such jobs very long, and when they leave, other engineers on their way up take their places. The total number of technician jobs filled in this manner would thus be about the number of engineers who each year start on this industrial path, assuming that the stay of the engineering graduate in the technician job would average one year.

The engineering colleges seem to feel that openings in technician occupations are important in their total placement program for engineering graduates. At the time the New York State Commission on Institutes was planning development of the institutes of applied arts and sciences for that state, representatives of the engineering colleges requested that the planning take into account the number of technician jobs held by young engineering graduates, and to recognize this source of technicians when planning the output of the institutes.

The training received by the engineer gives him more than enough basic training in mathematics, science and technology needed for the technician job, yet his training does not provide the manipulative skills or the specific technology required for many technician occupations. As the market becomes better supplied with graduates of technical institute type programs who are better prepared for these jobs than the engineering graduate, there may be a tendency for industry to prefer these graduates instead of those from engineering colleges. With the rapidly expanding opportunities in technician employment there is little danger that placement opportunities for engineering graduates in this field will be curtailed to any great degree.

The engineering student who drops out of college is another source of employment in technician jobs. The student who drops out after the first year of engineering training has relatively little to offer in the way of background for most technician jobs, and the second-year dropout is also limited in the specific training he has had which is of value as a technician. The first two years of engineering are largely filled with basic mathematics and science, and have little technology. In his study of occupational criteria and curriculum patterns in technical education programs (60) Roney compares a technical institute type curriculum with the first two years of engineering offered in an institution that has been offering both types of training for many years. In the 2-year technical program 27 percent of the work is devoted to mathematics and science as compared with 68 percent in the first two years of the engineering curriculum; while the 2-year technical program has 47 percent of the course work in the field of specialization as compared with 6 percent in the engineering curriculum.

Data in the study by Tolliver and Armsby (58) on engineering enrollments and degrees in 1959 indicate an estimated drop out at the end of the second year of engineering college of some 12½ percent. With an enrollment of 67,700 of freshmen engineering students in 1959, this would indicate that approximately 8,500 students were estimated to drop out after two years in engineering college. Some of these students transferred to other college curriculums, some entered military service, some went to work in non-technical fields, some entered technician occupations. How many took jobs as technicians is difficult to determine.

The overall contribution of the engineering colleges to meeting the needs for technicians is sufficiently large to be taken into consideration in overall long-term planning for technician education.

7. PRE-EMPLOYMENT PROGRAMS FOR THE TRAINING OF TECHNICAL WORKERS

Institutions that provide training for technical workers in industry have two important tasks: the preemployment preparation of persons to enter technical jobs, and the upgrading of workers presently employed in these fields. This portion of the report deals with preemployment training. A later section discusses extension programs for employed workers.

Some Historical Background of Technical Education.

Each era in the industrial development of the United States has called for educational programs, appropriate to the time, to provide the training needed by industrial personnel to keep pace with advancing technology. In the very early period most workers learned their tasks through on-the-job methods; practically no organized training programs were available.

During the early part of the 19th century the first engineering school in America was started, and the first of the mechanics institutes came into being. The Morrill Act, passed in 1862, provided Federal stimulus to the development of agricultural and mechanical colleges, with engineering programs which operated on a level comparable to that of present-day technical institutes. The engineering schools grew in numbers and in diversity of curriculums, with specialization in different branches of engineering. Gradually the level of instruction was raised, and engineering came to be recognized as a profession. Scientific and technological advance was slow, as compared with that at present, and at the turn of the century there were large gaps in the periodic table of the chemist, and the composition of the atom was largely unknown.

In 1917, Congress passed the Smith-Hughes Act to promote vocational education of less-than-college-grade, which soon stimulated the development of public trade schools that gradually took the form of vocational-industrial high schools. Some of these were organized as separate schools; others were set up as departments of comprehensive high schools.

Another development that has bearing on training for technical workers was the establishment of the mechanic arts high schools and the technical high schools, some of these coming into being before the turn of the century. Their programs included considerable drawing, together with a broad training in shop activities.

The American junior college initially was designed to duplicate the first two years of the four-year college curriculums. Gradually these institutions widened the scope of their activities to include curriculums in occupational training on both the skilled crafts and semi-professional levels, and many of these institutions changed their names to "community" colleges, in keeping with their enlarged scope.

The technical institute had its origin in the mechanics institutes of the 19th century. Over the years it has risen to a place of importance in the field of technical education. The principal objective of the technical institute is the training of engineering technicians, qualified to serve as aides to engineers and scientists. With programs offered at the post high school level, and curriculums that demand a high grade of student competency and effort, it gears in closely with present-day needs of industry for technicians. In the early years the technical institutes were largely private institutions; recently several have been developed as publicly supported schools. The technical institute has influenced the development of training programs for technicians in institutions of other types, and the term "technical institute type curriculum" is now commonly used to denote curriculums of high quality designed to train engineering technicians.

Recent technological developments -- computers, nuclear energy, astronautics, and the wide applications of automation -- have influenced greatly the scope of institutions concerned with technical education, and the content of the curriculum offerings. Title VIII of the National Defense Education Act of 1958 has done much to stimulate development of technician training in many types of institutions.

Since the passage of the NDEA Act, much progress has been made in the development of technician training programs in area vocational-technical schools, community colleges, technical high schools, and technical institutes. Specific aspects of this development are discussed in section 18.

Types and Levels of Training for Technical Occupations.

As outlined in section 1, technical occupations within industry range from relatively simple tasks learned in a short period to tasks of professional type which require a long period of advanced study. In between is a continuum of technical jobs, with needed training periods of full-time study, or its equivalent, ranging from a few months to two years or more. Many of the lower level jobs are filled by persons trained within industry largely through on-the-job instruction. Others of these jobs are filled by persons completing organized training programs of one year or less. The higher level jobs generally need the equivalent of two years of full-time study. These longer programs usually aim to prepare for a cluster of closely related occupations so that the graduate can enter any one of them, yet has a breadth of training that enables him to perform broader tasks involving interrelationships between these jobs together with other tasks of advanced level.

A specific occupation of "technical specialist" type often requires a type of worker who does not need the breadth of understanding or the level of ability required for tasks involving technical diversity. Many workers find satisfactions in such jobs for considerable periods of time, and thus desire training of such length and intensity as will fit them for such specialties. After they have worked a while and develop desires for greater breadth of responsibility they can supplement their initial training by extension courses. Thus there is a place in the overall educational pattern for these shorter programs - such as training for radio/TV servicing - in contrast with the longer programs needed to train electronic technicians.

Occupations of technician type are emerging in fields other than industry. Agriculture, business, the field of medicine and health, and the like, are changing technologically, as well as is industry. Less has been done to date in the training of workers for these fields than has been accomplished in the establishment of training programs for technicians in industry. But many institutions, such as the community colleges, have been expanding their offerings in these directions.

Institutional Patterns for Technician Training on the Post High School Level

Great diversity is noted in the types of institutional patterns utilized to provide technician training. Some schools offer only technician training in a single field; others offer only technician training, but in several different fields. Some schools combine agricultural and industrial technician training, with separate divisions in the same school. Some schools provide training for the skilled crafts as well as for technician occupations. Occasionally one finds a community college limiting its work largely to technician and skilled crafts training, yet including in the curriculums the liberal education courses commonly found in community college programs. Sometimes the technician training is in a technical institute division of a community college which also offers curriculums in liberal education or pre-professional education; or in a technical institute division of an engineering college or a university, with the program offered on the same campus or on a separate campus. In some cases a community college and a high school share facilities for technician training.

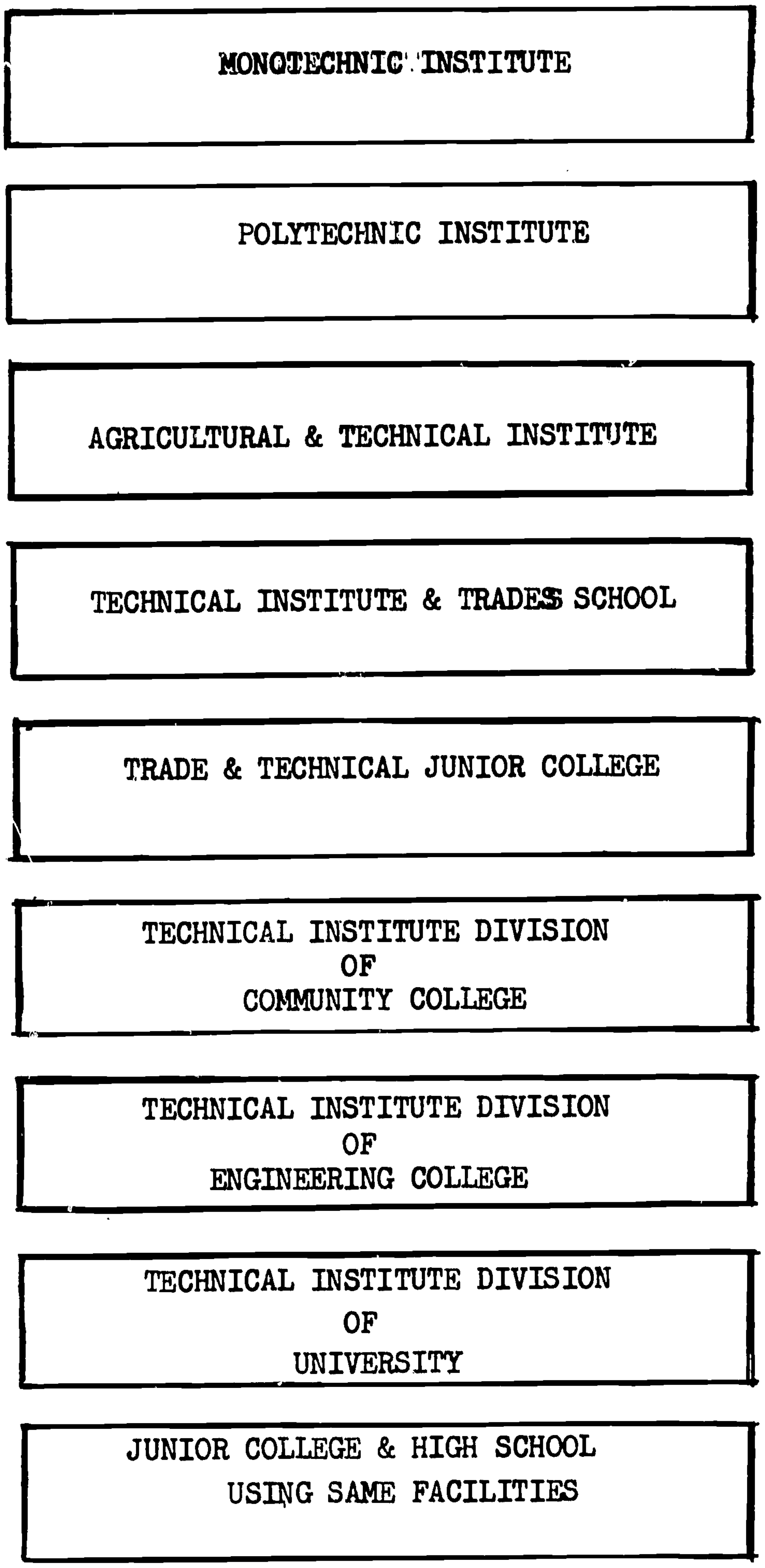


Figure 6. Some Post-High School Institutional Patterns for Technician Training

The long-term program for the training of technicians will probably be influenced by the trend in various types of institutions to move upward in their levels of training. The engineering colleges are moving toward more graduate study and to higher proportions of highly scientific content in their undergraduate curriculums. Technical institutes have a tendency to move upward into engineering college work, as in the case of Pratt Institute and Rochester Institute of Technology. Many junior colleges have aspirations to become four-year institutions. Area vocational-technical schools look forward to becoming community colleges. Some of our present high-quality technical institutes have grown out of trade schools. Some vocational industrial schools have developed technical institute departments. This upward shifting of institutions has a tendency to make the institutions concerned with technician training a bit more fluid than otherwise would be the case.

Some Characteristics of Good Technical Training Programs

Preemployment programs for the training of technicians vary considerably in scope and content, but all good programs have some common characteristics. Among these are the following:

1. Programs are directed toward the development of technical skills - defined as the ability to apply technical knowledge -- in specific fields of technology, with emphasis on problem-solving abilities.

2. The objectives of the programs are clearly defined in terms of the knowledge and understanding, skills and abilities, attitudes and appreciations required for the effective entrance of graduates into employment in the specific occupations or clusters of occupations toward which the programs are aimed.

3. Programs are rigorous in character, and aim for immediate productivity on completion of the training.

4. The overall programs make adequate provision for different levels of technical occupational life within industry, through appropriate curriculums, student selection, and instructional methods, and provide opportunity for persons of all suitable age levels and background to obtain desired preparation for technical occupations appropriate to their abilities, including adults and post high school youth.

5. The age- and grade-levels of the programs are in keeping with the practices of industry with respect to hiring age, maturity needed, and the like; and with the total length of full-time school attendance or opportunities which the State provides for a high proportion of its citizens.

6. Curriculums are based upon accurate and up-to-date analyses of the needs of the industries where graduates may expect to find employment.

7. Curriculums provide opportunity for the development of the manipulative skills appropriate to the technician jobs for which they provide training, as well as for the development of the technical skills needed.

8. Some specialization in the technology of the field is introduced at an early point in each curriculum.

9. Curriculums include such content in general education, designed to prepare persons as capable citizens in a democracy and appropriate to the age and grade level of the student, as is appropriate in the light of the total needs of the curriculum for basic and applied mathematics, science and technology,

10. Each curriculum provides instruction in oral and written communication appropriate to the field.

11. The instruction places emphasis on laboratory experiences designed for the teaching of scientific and technological principles through application to typical technical tasks.

12. The mathematics and science taught is articulated with the technology of the field toward which the program is aimed.

13. Students are selected on the basis of high motivation, aptitude for the field of training, and intellectual ability of a level commensurate with the rigorous character of the training program. Programs are most effective when designed for persons who have found their bearings through previous or collateral experience in industry, and desire intensive preparation for their chosen work.

14. Graduates of the programs show demonstrably superior achievement in the occupation immediately after entrance as compared with persons of similar age, aptitude and ability who have not had such training. A high proportion of the graduates find placement in the fields for which they studied, relatively soon after graduation.

15. Programs are kept in phase with technological developments.

In the section that follows, the roles played by the schools which provide preemployment training for technicians, including the technical institute, the community college, the area vocational-technical school, and the technical high school are discussed. These descriptions deal mainly with the preemployment programs of these institutions; a later section describes their contributions through extension courses.

8. TECHNICAL TRAINING IN THE TECHNICAL INSTITUTE

The institution most directly related to the training of technicians is the technical institute. It has been concerned with this field of training for many years, and is particularly identified with the training of engineering technicians. In the early years the most prominent schools of this type were private institutions, with programs devoted wholly or largely to technician training. With the expansion of this type of education, new institutional patterns emerged, with technician training provided through a technical institute division of the larger institution. The term "technical institute type" has come into general usage to denote training programs similar to those offered in technical institutes, and these are found today as units of universities, engineering colleges, community colleges, and vocational-technical schools.

In some respects the most appropriate institution for the training of technicians is the technical institute, independent of and separate from other types of educational programs. Its singleness of purpose enables it to drive directly toward its goal without having to conform to educational practices which do not always apply fully to the needs of technician training. The broad types of institutions however have other assets, which at times outweigh the advantages of the separate institutions. This section of the report deals with the technical institute as an institution, and with program patterns of technical institute type. Institutions that include technician training as a part of broader programs are discussed in later sections.

The nature of the technical institute has changed little since the first large study was reported in 1931 by the Society for the Promotion of Engineering Education (49). This study provided an excellent description of the technical institute. Here are some of the characteristics, adapted from those outlined in the study, and amplified somewhat:

1. It is post-secondary level, but distinct in character from a college or university.

2. Its objective is to prepare persons for technician occupations, which lie between the skilled crafts and the engineering profession. Its curriculums are largely of engineering technician type, but some may be included which prepare for occupations of industrial technician type or technical specialist type.

3. Its full-time curriculums are usually two years in length. Some curriculums may be one year or so in length, but such programs are rare.

4. Its entrance requirements are somewhat more flexible than those of the engineering college. High school graduation or equivalent preparation is usually required, but frequently there is no specification of the types of high school courses required as prerequisites. When specific prerequisite courses in mathematics and science are required, some technical institutes provide make-up classes, held during the summer previous to entrance or during the regular school year.

5. Its methods of teaching are relatively direct, with a strong emphasis on doing, and somewhat less stress on extensive book study than is found in the engineering college.

6. Its curriculum usually provides a reasonable amount of hand and other skill training, as well as the development of technical knowledge and understanding and technical skills.

7. Its curriculums are aimed to prepare persons for clusters of closely related technical occupations in selected fields, in contrast with the broad scope of engineering programs, and with the narrow scope of skilled craft training.

8. The number of contact-hours spent by the student in classroom, laboratory, drafting room, and shop is usually higher than that of the engineering college, and in this respect its pattern is more like that of a vocational-industrial school.

9. Its curriculums may include varying percentages of general education in such fields as economics, sociology, and human relations. Most curriculums provide for the development of skills in oral and written communication.

10. Its curriculums are developed through analysis of the occupational activities that are set up as employment objectives. These may vary in different localities, thus the curriculums are less standardized than are engineering curriculums. The analysis procedure usually takes the form of an activity analysis of the occupations in the cluster set as the curriculum objective, and often includes analysis of the mathematics and science needed for the occupations.

11. Its teachers are chosen primarily on the basis of practical experience in technical occupations, applied technical ability, and personal qualities, rather than on scholarly preparation. In this respect it resembles the vocational-industrial school more closely than the engineering college.

12. Many of the students enter the technical institute after they have had some work experience, and are thus more mature than those entering higher educational institutions directly from high school.

13. The instruction is rigorous in character, and on a level comparable to that of four-year collegiate institutions.

14. The credential given to graduates may take the form of a diploma or certificate, or that of an associate degree. Usually the associate degree requires somewhat more in general education courses than is required for the diploma or certificate.

The technical institute type of institution has been in existence as long as have engineering colleges. Wickenden and Spahr (49) trace its origin to the Gardiner(Maine) Lyceum, established in 1822, more than a dozen years before the first engineering curriculum was offered at Rensselaer. The Lyceum went out of existence after a decade, but apparently influenced the establishment of such schools as Ohio Mechanics Institute (in 1828), and the mechanics institute out of which has grown the present Rochester Institute of Technology (in 1829). Many of our present-day engineering colleges began as institutions which fulfilled in large measure the functions of technical institutes. Among these are Brooklyn Polytechnic Institute, Cooper Union, Drexel Institute, Armour Institute, and Carnegie Institute of Technology.

At the time of the S.P.E.E. Study of Technical Institutes (49), the data revealed a relatively limited number of institutions that provided technician training, located mainly east of the Mississippi River and north of the Ohio. Among the institutions listed as providing full-time day courses were the following:

Bliss Electrical School, Washington, D. C. (Proprietary)
Bradford-Durfee Textile School, Fall River, Mass. (State)
Bradley Polytechnic Institute, Peoria, Ill. (Endowed)
California Polytechnic Institute, San Luis Obispo, Cal. (State)
Chicago Technical College, Chicago, Ill. (Proprietary)
Dunwoody Industrial Institute, Minneapolis, Minn. (Endowed)
Franklin Union, Boston, Mass. (Endowed)
Heald Technical School, San Francisco, Cal. (Proprietary)
University of Idaho, Southern Branch, Pocatello, Idaho (State)
Iowa State College, Ames, Iowa (State)
Lowell Textile Institute, Lowell, Mass. (State)
Milwaukee School of Engineering, Milwaukee, Wis. (Proprietary)
New Bedford Textile School, New Bedford, Mass. (State)
Ohio Mechanics Institute, Cincinnati, Ohio (Endowed)
Philadelphia Textile School, Philadelphia, Pa. (Endowed, Public Aid)
Pratt Institute, School of Science and Technology, Brooklyn, New York (Endowed)
Wentworth Institute, Boston, Mass. (Endowed)
University of Wisconsin, Extension Division, Milwaukee, Wis. (State)

The study indicated that the above list provided a fairly complete inventory of such technical schools. They showed considerable activity over the country but with a striking lack of unity in organization, curriculums, and methods. It was noted also that little of the total activity was carried on in schools which made technician training their primary function. The State universities provided technician training as a minor part of their total programs, some schools such as Dunwoody Institute and Wentworth Institute also operated training programs for the skilled crafts, and schools like Pratt Institute and Rochester Mechanics Institute offered training in other fields as well as that for technicians.

Although this study was made more than 30 years ago, the situation of the technical institute appears to have changed little with respect to its place and mission in American industry, as indicated in the following quotation:

> "All facts considered, the case for the technical institute is primarily contemporary, rather than historical. Its past evolution in America reveals the difficulties to be met and overcome in its future development, but the sanctions of its existence are in the new conditions of our industry, with its rising specialization, in the modern problem of technological unemployment with its attendant needs for intensive reeducation of men displaced and in a social philosophy which aims to provide not uniform but varied educational opportunity of equal excellence for all men." (49)

Many changes have occurred in the intervening years in the institutions named in the 1931 SPEE report. Several have become engineering colleges. In the annual survey of technical institutes for 1954-55 (48) Smith reports on 63 institutions that offer full-time programs, with a total enrollment of 26,766 students. Although this survey may have omitted a few institutions it indicates a large growth over the 18 schools listed in the 1931 S.P.E.E. report.

In 1957 the U.S. Office of Education took over the task of making an annual survey of enrollments and graduates in various types of organized occupational curriculums less than four years in length on the higher education level, carrying on the survey made by Smith in previous years, but adding certain items to the total coverage. The report on enrollments in the fall of 1958 (61) showed 252 institutions which reported organized occupational curriculums of engineering-related type, with a full-time enrollment of 38,785 students. It is probable that some programs are included in these data which were excluded from the previous survey, yet the growth in enrollments has been substantial.

In interpreting data on programs reported as of technical institute type, one must keep in mind the different interpretations of what is meant by technical institute type education, especially when data are collected by questionnaire. When data are gathered on engineering education, the problem of interpretation of meaning is largely absent, since engineering colleges have accreditation procedures that have been operative for many years. Although considerable variation is found in curriculum patterns of engineering colleges, and some differences in qualities of programs, there is a high degree of common understanding of what is meant by engineering education. This is not true with respect to training programs for technicians. Although the technical institute is coming to be more generally recognized as the type of institution most closely associated with the training of technicians, as yet it has a long ways to go before it achieves such recognition from educators as a whole and from the general public.

Accreditation of Curriculums

In an effort to work toward a better balanced system of technical education in America the Engineers' Council for Professional Development, which represents the major engineering societies of the United States and Canada, in 1944 appointed a Subcommittee on Technical Institutes within the Council's Committee on Engineering Schools. After lengthy study the subcommittee recommended a basis for accrediting programs of technical institute type, that was later adopted. The general purpose of the accrediting program was to raise the standards of instruction in technical institute programs, and to place this type of education on a basis of strength and usefulness comparable to the position it holds in other industrial nations. Early in 1945 the subcommittee announced that it was ready to act on applications for inspection of curriculums, and outlined the scope of its activities and the procedures it planned to follow (20). It defined the technical institute as follows:

"1. The purpose is to prepare individuals for positions auxiliary to, but not in, the field of professional engineering.

2. Curricula are essentially technological in nature, based upon principles of science, require the use of mathematics beyond the high school, and emphasize rational processes rather than rules of practice.

3. Curricula are briefer, more intensive, and more specific in purpose than collegiate engineering curricula, although they lie in the same general fields of industry and engineering. Their aim is to prepare individuals for specific technical positions or lines of activity rather than for broad sectors of engineering practice.

4. Training for artisanship is not included within the scope of education of technical institute type."

The standards set up by the subcommittee included the following:

1. Curriculum length of not less than one academic year of full-time study or the equivalent in part-time study.

2. Admission on the basis of high school graduation or equivalent.

3. Curriculums that are technological in nature, employing the application of physical science and the techniques of mathematics to the solution of practical problems, with a prescribed sequence of related courses in a specific field.

4. Instruction to emphasize laboratory work. Instruction by correspondence study may be included.

5. Qualified teaching staff and adequate physical facilities.

6. Programs to be offered by an organized school or division of an institution or industry devoted to the specific aim of providing technical institute programs, which are stable organizations with adequate financial support, and which have demonstrated achievement in the technical institute field.

The type of institutions and programs listed by the subcommittee as within the scope of the accreditation program were:

Endowed technical institutes
State, municipal, or federally supported technical institutes, other than junior colleges
YMCA schools
Junior colleges, public or private
Extension divisions and evening sessions of colleges and universities
Training programs and schools associated with industries
Proprietary schools
Denominational schools
Correspondence schools

Among the principles of accreditation adopted by the subcommittee are the following:

1. Individual curriculums are accredited.
2. Curriculums are appraised on invitation of the institution.
3. Curriculums are accreditated upon the basis of both qualitative and quantitative criteria, evaluated through data secured from catalogues and other publications, from questionnaires, and visits of inspection committees.

In October 1946, the Engineers' Council for Professional Development accredited its first technical institute curriculums-- six in all --at Bliss Electrical School, Capitol Radio Engineering Institute, and Wentworth Institute. In 1947 five more curriculums were added to the list --at Academy of Aeronautics, Aeronautical University, Franklin Technical Institute, and Northrop Aeronautical Institute. The accredited list of curriculums has grown from the six listed in 1946, at three institutions, to 116 curriculums at 32 schools in the 1961 list, Year by year new schools and new curriculums are added to the list, and schools and curriculums previously listed are dropped. Some changes have occurred in the requirements for accredited curricula; at present such curriculums must be not less than two years in length, and must have titles which terminate in the word "technology". The reports of the Engineers' Council for Professional Development show the numbers of accredited curriculums and the numbers of schools in which they are offered, by year, as follows:

Year	Number of schools	Number of curriculums
1955	30	93
1956	32	95
1957	35	109
1958	36	116
1959	35	118
1960	33	121
1961	32	116

In comparing the list of accredited curriculums for 1956 with that for 1961, one notes an increase in the number of accredited curriculums from 95 to 116, yet the number of schools remained the same. The 32 schools in the 1961 list included 23 that were on the 1956 list, with nine new ones added. During these years nine schools on the 1956 list had been dropped from the list. It is probable that some of these schools had curriculums that did not meet the new requirement of a minimum length of two years of full-time study.

The geographical spread of schools with one or more E.C.P.D. accredited curriculums covers 16 states and the District of Columbia. As one looks at the areas of industrial activity in the United States, especially the larger cities, one notes great gaps in public programs of technical institute education that are on the E.C.P.D. list. No programs under public support are shown for such cities as:

Baltimore	Detroit	Milwaukee
Boston	Kansas City	Minneapolis
Chicago	Louisville	Philadelphia
Cincinnati	Los Angeles	Pittsburgh
Cleveland	Memphis	Portland
Denver	Miami	Providence
		Seattle
		Washington, D.C.

A few of these cities have private schools with E.C.P.D. accreditation. Some institutions that offer technical institute training have not felt the need for such accreditation as their programs are accredited by State or regional accrediting agencies.

There is considerable merit in nation-wide accrediting of technician training programs. The placement market for graduates from such programs extends far beyond State borders, and there is value to the graduate in having attended an accredited program, recognized by the employer. The range of programs accredited by E.C.P.D. is largely limited to those training engineering technicians. Perhaps there is need for a broadening of the scope of nation-wide accreditation.

Curriculum Patterns in Technical Institute Education.

The objective of the curriculum of technical institute type is the development of technical skills, defined as abilities in applying technical knowledge and understanding to practical industrial problems. To attain this objective the content of the curriculum must include mathematics, science and drawing (basic and applied) of appropriate level and type, together with the technology of the field toward which the instruction is aimed. If the curriculum is designed to prepare students for technical occupations in the production field it usually contains courses dealing with certain aspects of management. Most curriculums have courses in oral and written communication, and many of them include a reasonable amount of general education content. As one looks at the makeup of curriculums in different schools one finds great variations in content. Yet one observes some overall similarities in the distribution of content among the various types of courses.

Henninger analyzed the ECPD-accredited curriculums for the year 1957 (24) and found an average percentage distribution of content as follows:

Basic mathematics and science	23.2%
Major technical specialty	45.4
Allied technical specialties	17.2
Administrative & managerial subjects	4.0
General subjects	10.2
	100.0%

The curriculums that yielded the above data included aeronautics, air conditioning, architecture and building construction, civil technology, electronics, industrial electricity, mechanical technologies, and automotive and diesel technology. Some of these fields indicated considerable variation in the proportion of allied technical specialty courses as compared with the major specialty, and in the general education included in the curriculums. The overall picture one gets from this analysis is that of a curriculum that consists largely of courses of applied technology supported by basic mathematics and science.

The technical institute type curriculum differs materially from the first two years of an engineering curriculum, with which it is often confused. Roney (40) points out these differences, and shows striking contrasts in the proportions of specialized technical courses, and of mathematics and science. The data are shown in graphic form in Figure 7.

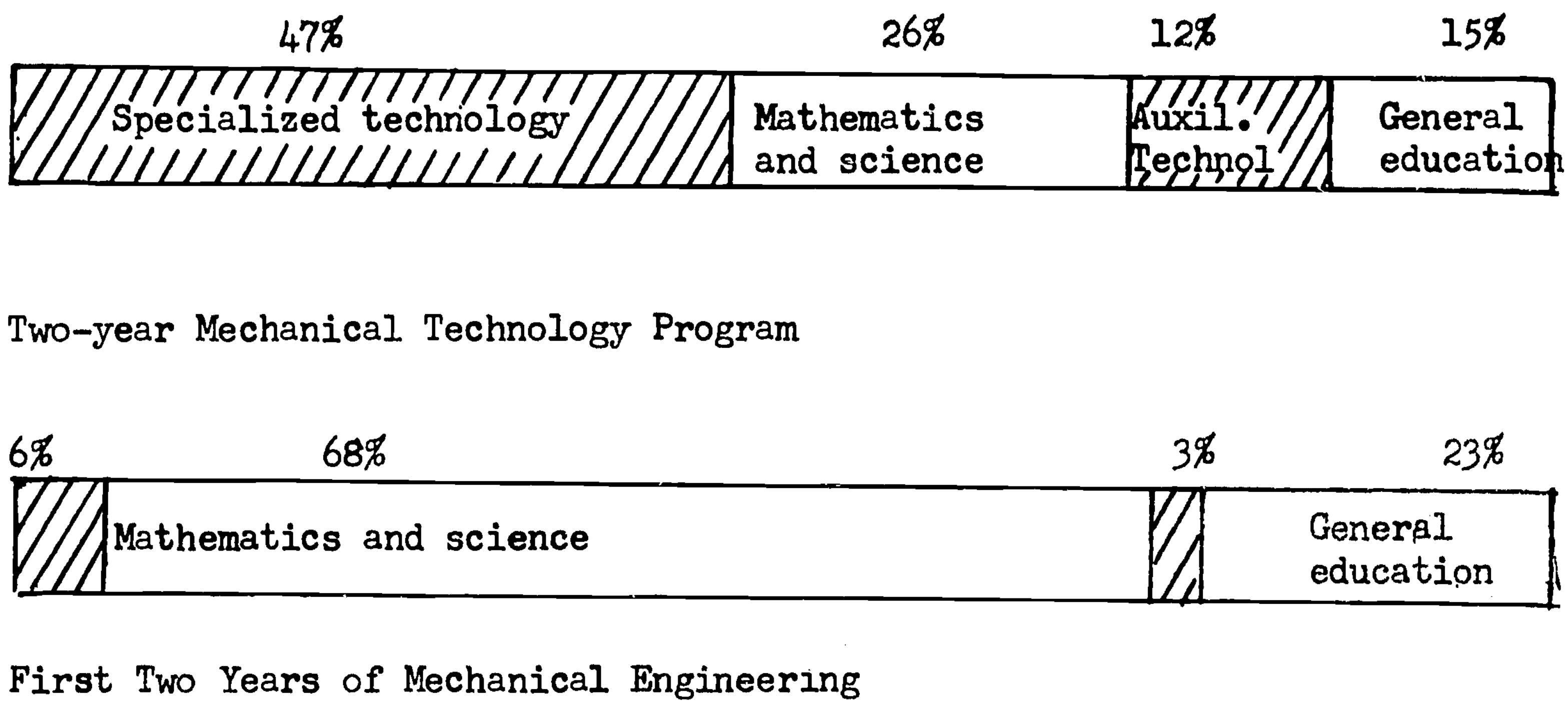


Fig. 7. Comparison of curriculum content distribution in Mechanical Technology and first two years of Mechanical Engineering in one institution.

The first two years of the engineering curriculum lay the foundation for later courses in technology by providing large amounts of science and mathematics. In these years the student gets little contact with the specific field for which he is studying. In contrast, the typical technical institute student is introduced to his field of specialization very early in his program. Perhaps the greatest difference in the curriculum content of engineering and technician training programs is the broad theoretical approach of the engineering curriculum as compared with the applied technology approach in technician training. The type of student who is attracted to the technical institute is the one who prefers to deal with direct application of mathematics, science and technology to practical situations, and who likes direct contact with instruments, machines and equipment as well as theoretical design.

Many training programs for the skilled crafts are now operated on the post high school level, and a comparison of a curriculum for this field with one for the training of technicians may be in order. The skilled crafts curriculum emphasizes shop activities, and the objective is to develop the manipulative skills needed for the craft, together with the technical knowledge and understanding required for performing the skilled tasks. The level of mathematics, science, and technology needed is lower than that of the technician occupation, and these subjects are taught in direct relation to the shop activities. A rough comparison between skilled craft and technician curriculums is shown in Figure 8, which compares a selected program in machine shop practice on the post high school level with the average content distribution in 12 selected curriculums in mechanical technology. In the mechanical technology program the student gets some experience in the machine shop, but the primary purpose of such instruction is the development of understanding of machine processes rather than the development of skills in machine operation.

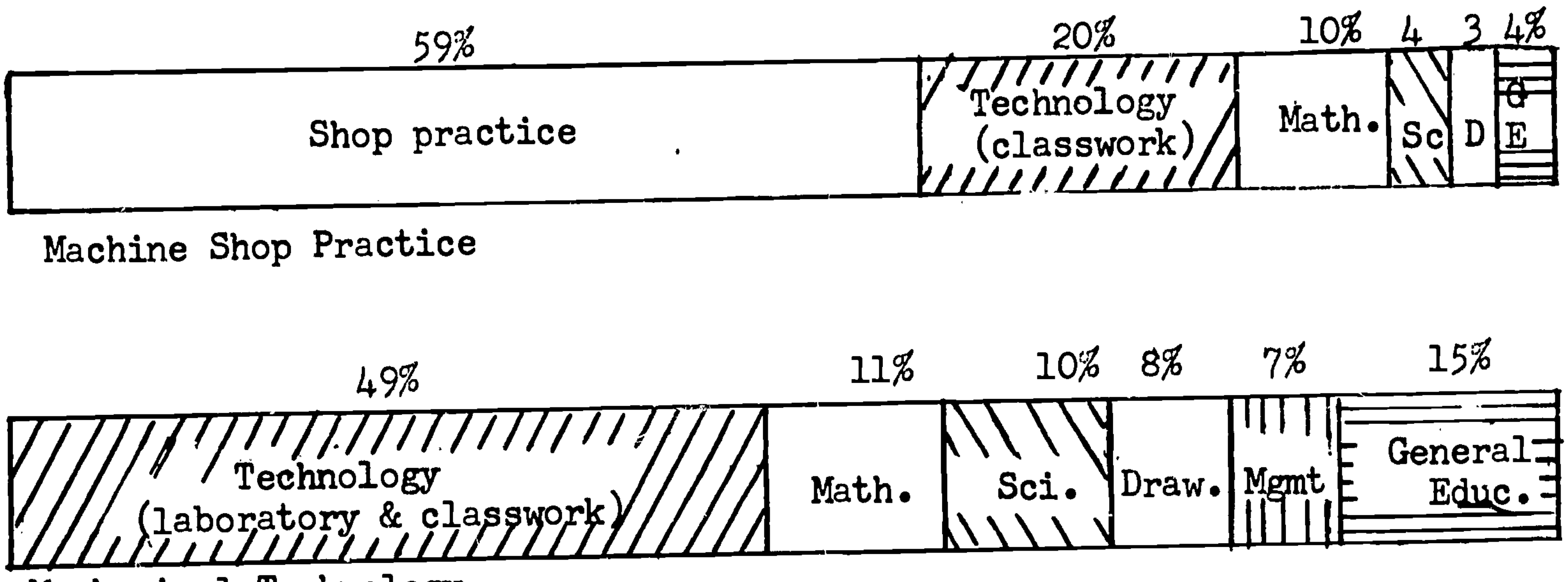


Fig. 8 Comparison of curriculum content distribution in Machine Shop Practice and Mechanical Technology.

As indicated earlier in this report, considerable variation in curriculum content is found in different institutions offering programs in the same technician field. Two sample curriculums, however, may give a general picture of the nature of the content. The curriculum shown in Table X was developed by a State university that operates a technical institute division, on contract with the Area Vocational Education Branch of the U.S. Office of Education. (57)

TABLE X. ELECTRONIC TECHNOLOGY CURRICULUM

First Year	Semester Hours
First Semester	
Technical mathematics (algebra and trigonometry)	4
Direct current circuits and machines	5
Social science	3
Technical drawing	3
Communication skills	3
	18
Second Semester	
Technical mathematics (applied analytical geometry and calculus)	4
Time varying circuits	5
Basic electronics	5
Shop processes	1
Technical report writing	1
Graphic analysis	2
	18
Second Year	
Third Semester	
Engineering science (physics)	4
Circuit tracing	2
Special electronic circuit design and analysis	5
Transmitter theory and operation	5
	16
Fourth Semester	
Research report (special problem)	2
Ultra-high frequencies and microwaves	5
Television circuits	5
Industrial electronics	5
	17

Total semester hours-------69

The curriculum in Mechanical Technology in Table XI is outlined in the 1962-1963 catalog of the New York City Community College. The degree of Associate in Applied Science is awarded for satisfactory completion of this curriculum.

TABLE XI. MECHANICAL TECHNOLOGY CURRICULUM

Required courses	Credit hours
Industrial processes	4
Engineering drawing	4
Industrial organization	2
Manufacturing processes	1
Mechanics and strength of materials	6
Production processes	1
Basic thermodynamics	3
Machine design	5½
Metallurgy	5
Metallurgical laboratory	1
Materials testing laboratory	1
Planning for automation	3
Applied thermodynamics	3
Mechanical laboratory	1
Industrial plant planning	4
Fundamentals of electricity	3½
Mathematics	6
Physics	4
Communication arts and skills	6
Social science electives	9
Total credits required	73

The titles of technician training curriculums are many and varied. Here are some of them:

- Air conditioning technology
- Automotive technology
- Aviation technology
- Building construction technology
- Chemical technology
- Civil technology
- Computer technology
- Diesel technology
- Design technology
- Electrical technology
- Electronic technology
- Fire protection technology
- Gas and fuel technology
- Industrial laboratory technology
- Industrial supervision
- Industrial technology
- Inspection technology
- Instrumentation technology
- Mechanical technology
- Optical technology
- Petroleum technology
- Photographic technology
- Plastics technology
- Technical illustration
- Technical sales
- Tool technology

Relationships Between Technical Institutes and Engineering.

Institutions that have been known over the years as technical institutes have maintained close relationships with engineering education. Many highly skilled technicians of the engineering technician type work closely with engineers, performing many of the tasks previously carried out by engineers. The qualifications of these technicians are thus akin to those of engineers, though more limited in scope and level. Educators concerned with the training of technicians face problems similar to those of engineering educators. Many of these educators have had engineering training and engineering experience. They feel that their interests are closely allied with those of engineering educators, and that their professional help can best come from this direction. Many of them are members of the American Society for Engineering Education. The first study of technical institutes was made by the forerunner of this organization.

The establishment of a Technical Institute Division of A.S.E.E. provided a direct avenue of relationship, and the programs of this Division at the annual conventions of the A.S.E.E. provide professional stimulus in technical institute education development. The early nucleus of technical institute educators was made up largely of leaders in private technical institutes, and technical institute divisions of engineering colleges. More recently the membership of the Division has included other educators concerned with technical institute type education, from community colleges, area vocational-technical schools, and the like. Leaders in the Technical Institute Division of A.S.E.E. have been active in the promotion of technical institute education, and in upholding of standards for such programs.

The Role of the Private Technical Institute

New types of educational programs usually originate in private schools, which have more freedom to experiment in new directions than is found in publicly supported institutions. Technical institute education started in private institutions, and for many years this type of institution provided most of the training of technicians. As the needs become more evident, publicly supported engineering colleges entered the field with their technical institute divisions. Later, technical institute type curriculums emerged in community colleges and area vocational-technical schools, or were established directly as state-supported technical institutes.

The role of the private institution is an important one, for experimenting in new fields and in carrying on programs of special types. The private school helps carry the burden of the total load, yet its contribution is usually more in the form of qualitative service than in the training of large numbers of persons. The large mass of the training sooner or later is taken over by public institutions, supported by taxation.

In recent years few private technical institutes have come into being, in contrast with the reasonably large growth in those with public support. This is perhaps as it should be, with the private school continuing to exert leadership in new developments, and the expansion to meet needs for large numbers of trained technicians coming through the public institutions.

Institutional Patterns of Technical Institute Type.

The preceding section has combined discussion of the technical institute as an institution and discussion of technical institute type education. This seemed necessary as the type of education is so closely related to the technical institute as an institution. There are few separate technical institutes in the United States today. Most of the technical institute type education is provided by institutions of which technician training is only a part. These institutions are discussed in the sections which follow.

9. TECHNICAL TRAINING IN THE COMMUNITY COLLEGE

The community college today plays an important role in technical education of subprofessional level, and its importance in this field appears to be increasing. Emerging from the junior college which was developed largely to meet the needs for additional facilities and service in higher education of liberal type, the community college today provides a wide range of educational activities for youth and adults.

The junior college developed from two directions -- upward from the high school, and downward from the university. It is a distinctly American institution, designed initially to help bridge the gap between high school and college, and to make higher education available to more persons at lower cost to the student. Initial activity came in private institutions, and spread to publicly supported programs growing out of secondary schools. The Joliet Junior College, getting under way in 1901, is generally recognized as the first public junior college. California soon became active in the field, with the establishment of Fresno Junior College in 1910, followed rapidly by Santa Barbara, Los Angeles, Bakersfield and Fullerton. State legislation in 1917 gave impetus to the growth in California.

The junior college movement had become well under way by 1920, and the first meeting of the American Association of Junior Colleges was held in 1921. As the movement developed, and the scope of curricular offerings widened to give increased emphasis on occupational education, many of the leaders felt that the title "junior college" was not really indicative of its breadth of activity. After some search for a new title, the term "community college " came into use. Although a large number of institutions call themselves junior colleges, the use of the newer title appears to be expanding rapidly.

Merson outlines the functions of the community college as follows: (34)

1. Lower-division, university-parallel programs for those who seek extended education required by the professions.

2. Vocational-technical education for those who seek employment in business and industry following two years or less of college education.

3. General education to increase civic and social competence.

4. Adult education for those seeking upgrading or change in employment.

5. Guidance for those who need professional counsel.

6. Repair education for those whose backgrounds have been meager.

He points out that a variety of programs, differing both vertically and horizontally, is essential in higher education of community college type to provide for meeting individual differences and the diversified needs of society.

To meet these needs, a wide range of curriculum offerings is required. Transfer curriculums include liberal arts, agriculture, business, engineering, law, medicine and many others. Occupational training curriculums include those which prepare for entrance into semiprofessional occupations in industry, agriculture, business, the medical and health field, and others, and curriculums which prepare for skilled and semi-skilled occupations in many fields. The total program includes both preemployment and extension offerings. Accreditation of institutions is usually by the regional accrediting association of the area in which the community college is located.

Considerable diversity is found among community college students -- in academic aptitude, in age, and in the objectives sought. Medsker reports several studies on the academic aptitude of junior college students, (32), from which he concludes that the average academic aptitude level of students entering junior colleges is somewhat lower than that of those who enter four-year institutions but there is a wide range of abilities among the junior college students, and many of them are superior to many in the four-year colleges.

Differences are noted between the academic aptitude of transfer students as compared with "terminal" students. One study of some 6,000 students in 13 junior colleges, approximately equally divided between transfer and terminal students, reported by Medsker (32), showed a mean ACE score of 99 for transfer students as compared with a mean score of 91 for terminal students. In this study the scores for technical terminal students showed a mean of 96, somewhat higher than those for other terminal students.

The age range of junior college students is wide. One study of some 13,000 regular day students in 10 junior colleges, reported by Medsker (32), showed 53 percent in the age range 16 to 22 years, 31 percent in the 23-29 year bracket, and 16 percent 30 years of age or over. Fields reports a study of day students in the Business and Technology Division of Long Beach City College (23). This study showed some 18 percent under 20 years of age, and 43 percent over 30 years old. The admission requirements of the junior college are somewhat more liberal than those for four-year colleges, as many of them admit students who are 18 years of age and are able to profit by the instruction even though they have not completed high school. This practice tends to raise the average age of the junior college students, since many of them have been away from high school for some years.

The total enrollments of students in junior colleges have grown rather steadily over the years. Methods of collecting enrollment data differ somewhat today from those used in the early years, but general comparisons can be made. In 1915, less than 2500 students were enrolled in 74 institutions. In 1929-30

the reported enrollment in 436 institutions was 74,000. In 1945-46 the enrollments had reached 295,000, in 648 junior colleges. In 1959-60 the data for 663 institutions showed 816,000 total enrollment, including part-time students.

The junior colleges are widely scattered throughout the nation, with some concentrations in certain states. Data in American Junior Colleges - 1960 (1), reported for 590 institutions, show six states with 25 or more junior colleges, eight states with 15 to 24 institutions, five states with 10 to 14, and 33 states with fewer than 10 junior colleges. In these data the branches of an institution are counted as separate junior colleges. California leads the list with 66, New York has 47, and Texas has 44.

What are the trends with respect to community colleges? Growth in the direction of much greater development seems to lie ahead. Schools which started out in New York as Institutes of Applied Arts and Sciences rather quickly moved toward community college programs. Current developments in such states as New Jersey and North Carolina seem to be heading toward community college status for schools now considered as area vocational schools. Many schools with emphasis only on transfer curriculums are broadening their offerings. And perhaps with the heavy potential increase in college attendance forecast for the years immediately ahead the community college will face new challenges.

The training of technicians is a relatively new development in so far as the community college is concerned. Much of it has developed within the past ten years. In 1949 the author of this report travelled some 10,000 miles by automobile, visiting schools mainly in southern and western states looking for training programs of technical institute type. Here and there he found an institution carrying on training that was clearly of technician character. Among these schools were Southern Technical Institute, University of Houston Institute of Technology, and the apprentice training program of Newport News Shipbuilding and Drydock Company. Several schools had small programs in radio or drafting that could be called technical. Occasionally one came across an engineering aide curriculum, as in the Tacoma Trade-Technical School; or a technical curriculum in oil well drilling, as at Kilgore College. The trip included visits to 15 California junior colleges. All in all, he found relatively little technical training, and almost none of a scope and quality envisioned by E.C.P.D. accreditation. Many of the leaders of the institutions visited were aware of the needs and were looking ahead.

In the S.P.E.E. Study of Technical Institutes, published in 1931 (49), one of the conclusions was stated as follows:

> "There is no basis in experience for expecting the junior college of a mixed character to do the work of a technical institute successfully."

As a part of the report of the study of vocational-technical training made by the U.S. Office of Education in 1944 (22), Robert Spahr, one of the authors of the S.P.E.E. Study, comments on the above conclusion as follows:

> "In the late twenties, when schools were listed and data were being collected for the international study of technical institutes, the junior colleges had not yet entered this field in sufficient numbers and development to justify any fair conclusions. Time will tell the results of their rather interesting and voluminous efforts in this area of education."

At the time this statement was made (1944) the junior colleges had made a start in technician training, but hardly more than that. In the intervening years since 1944 the situation has changed considerably. In 1959 Wood studied the curricular offerings in 62 junior colleges and found programs of technician character in 30 of these institutions (70). The other 32 junior colleges are located in nonindustrial areas. The curriculums -- 86 in all --included electronics technology, engineering technology, drafting technology, civil technology, electrical technology, mechanical technology, chemical technology, petroleum technology, and others.

The National Defense Education Act, under Title VIII, provided Federal funds for the development of programs for the training of highly skilled technicians in fields vital to the national defense. This Act greatly stimulated activity in this field in the community colleges as well as in other types of institutions. A summary of programs in the junior colleges and 4-year colleges, which received financial aid under this Title is shown in Table XII, prepared from data furnished by the U.S. Office of Education.

TABLE XII. ENROLLMENTS IN TITLE VIII PREEMPLOYMENT AND EXTENSION PROGRAMS IN JUNIOR AND 4-YEAR COLLEGES - Fiscal Year 1961 (1)

State	Number of institutions	Enrollments Preemployment	Extension	Total
Alaska	2	0	33	33
Arizona	1	0	60	60
California	*	8,123	24,773	32,896
Colorado	3	349	309	658
Florida	9	726	158	884
Idaho	3	250	130	380
Illinois	5	327	0	327
Indiana	1	15	0	15
Iowa	6	105	577	682
Kansas	3	70	529	599
Maryland	3	166	0	166
Michigan	14	2,200	1,239	3,439
Mississippi	5	220	42	262
Montana	1	47	0	47
Nevada	1	21	320	341
New Mexico	1	60	0	60
North Dakota	1	198	0	198
Oklahoma	6	627	426	1,053
Oregon	5	197	13	210
Pennsylvania	1	0	57	57
Texas	8	805	2,605	3,410
Utah	2	116	144	260
Washington	6	267	995	1,262
Wyoming	1	14	0	14
Puerto Rico	1	58	0	58

* Data representing 61 junior colleges
(1) Provisional figures, subject to final review of State reports.

The data in Table XII indicate a substantial contribution to technician training on the part of the institutions of junior college type. Some important omissions may be noted in this table, such as the community colleges of New York State which did not participate in Title VIII funds. Taken all in all, the scope and size of community college programs for the training of technicians are large enough to meet a considerable share of the total task.

The community college has certain strengths and certain weaknesses with respect to educational service in the technician training field. Among the strengths are the following:

1. The large numbers of such institutions, and their wide geographic spread.

2. The wide range of fields of training of technician level included in their programs -- agriculture, business, medical and health, etc.,-- in addition to the field of industry.

3. The prestige of an institution which is recognized as doing work of college level.

4. The relatively adequate financial support accorded to them by local and state legislative groups.

5. The range of general education courses available to technical students.

6. The potential for expansion and enlargement of programs.

In contrast, the community college has certain weaknesses:

1. The academic approach to technical education followed by many junior college administrators.

2. Some domination of technician programs by academic standards not pertinent to this type of education.

3. Confusion between technician training and preengineering training, and the tendency to utilize existing courses designed for transfer students as parts of the technician training curriculums.

4. Fixed requirements of academic courses for all students working toward associate degrees, desirable to a certain extent but sometimes carried to excess.

5. Placing preprofessional engineering curriculums, technician training curriculums, and skilled crafts training under the same division of the institution, without sufficiently strong leadership to handle each effectively.

6. Insufficient recognition of the need for specialized laboratory equipment required for successful technician training.

7. Frequent lack of close working relationships with industry, and the utilization of strong advisory committees.

The strengths and weaknesses outlined above are not found in all community colleges. When the institution develops out of a previous technical program--as in the case of some of the New York community colleges --the weaknesses tend to disappear. When an academic type of junior college moves into the more comprehensive type, the weaknesses are more likely to be present.

Perhaps the most important aspect of success in technician training in the community college is the ability of the leadership to deal with the many problems. This is especially true when an academic-type institution moves into technician training. The really competent leader studies the new problems and copes with them.

In the years that lie ahead, the role of the community college in the field of technician training promises to be an important one --perhaps more important than that of any other type of institution. The separate technical institute may be the most effective instrument for handling this type of training, but their numbers are few and do not seem to be expanding to any great degree. The community college with leadership truly competent in technician training may well provide a large share of the institutional training of technicians in the decades ahead.

10. TECHNICAL TRAINING IN THE AREA VOCATIONAL SCHOOL

"No more detailed definition of an area vocational education program is needed than its name. These programs have two outstanding characteristics -- they are vocational in nature, providing training which leads to employment in specific occupations, and they serve the potential students of more than a single community or local school district. An area vocational program is a service and a solution to the problem of providing vocational training for all who need it and can profit from it."

In this manner is area vocational education defined by the American Vocational Association in the report prepared by its Research and Publications Committee.(2). Under this broad interpretation could be included all types of institutions which provide vocational education which meets the specifications outlined above. The AVA seems to be concerned, however, with a somewhat narrower interpretation which would limit such programs to "less-than-college grade" courses conducted under public supervision and control on an organized, systematic class basis, made available to residents of the State or an area thereof designated and approved by the State Board for Vocational Education, who either have completed junior high school or, regardless of their school credits, are at least sixteen years of age and can reasonably be expected to profit by the instruction offered. The interpretation of the expression "less-than-college-grade" includes all programs of vocational education which do not lead directly to a baccalaureate degree or whose courses normally are not given credit toward such a degree. Area vocational education programs under this definition would include those found in area vocational schools, in community colleges, in agricultural and technical institutes, in "terminal" programs of vocational education type offered under the auspices of colleges and universities.

Since previous sections have dealt with technicial training in community colleges, the discussion that follows is limited to area vocational schools whose offerings are generally limited to curriculums and courses preparing persons for skilled and technical occupations.

Many reasons can be given as to why area vocational schools are necessary in a total program of vocational education. The increasing needs of industry and business cannot be met with present facilities. Many youth in agricultural communities have to migrate to find jobs, and these youths are needed if employment demands are to be met. Small local high schools cannot afford the equipment needed for effective instruction, and cannot recruit sufficient numbers of students to make efficient operation possible. The increasing demands of industry for more mature and better trained workers is increasing the age-and grade-level of vocational education. Increasing numbers of out-of-school youth and adults are seeking opportunities for vocational training.

Area vocational schools are found in urban settings with heavy industrialization, in areas predominantly rural, and in in-between types of communities. Those in urban settings provide extension programs as well as preemployment training; those in non-industrial areas often provide only preemployment training.

The scope and level of the area vocational programs varies considerably. Some schools include agricultural and business training, as well as that which prepares for industry. Many of them limit their offerings to preparation for the wide range of occupations found in industry. These latter schools are mainly concerned with providing training for the skilled trades, though recently many of them have developed programs for the technical occupations. With the increasing demands of industry for technically trained personnel, this phase of training appears to be receiving much attention.

The typical area vocational school includes programs on the high school level, and on the post-high school and adult levels. The main emphasis appears to be toward meeting the needs of youth who have graduated from high school, youth who have dropped out of high school and have discovered that they need training, and adults who may want to prepare themselves for new industrial and technical occupations, or who may wish to upgrade themselves while still working. Many area vocational schools enroll considerable numbers of high school youth, either enrolled full time at the area school or dividing their time between this school and a high school in the vicinity. The offerings for high school students will probably be continued for some time, although the long-term trend is unmistakably in the direction of providing most training for the skilled and technical occupations in programs beyond the high school.

The area vocational school which is located in a non-industrial area limits its offerings to preemployment programs. It recruits students from its immediate area, and sometimes from considerable distances if the school has highly specialized curriculums found only in few schools. It places its graduates in jobs in a placement market which goes far beyond the immediate geographical area served by the school. Sometimes youth in small communities go to the area school for specialized training - in service occupations, for example - and then return to jobs in their home communities. The area vocational school located in an urban area not only provides preemployment programs for persons in that area, but offers extension programs for employed workers. This is an important part of the total program.

As indicated earlier, area vocational schools may offer programs not only in the industrial and technical fields of industry but may include business and agriculture as well.

In a comprehensive system of area schools planned on a state-wide basis, and developed to meet state-wide needs of industry as revealed through an adequate occupational survey, the total program will probably show considerable variation in the curriculums provided in the different schools. Since the needs for workers in the skilled crafts and the skilled specialty occupations are considerably greater than the needs for technical workers, most of the schools in the state-wide program will provide offerings in these fields. Some schools may confine their efforts largely to technical

programs, for the training of technical specialists, industrial technicians, and possibly engineering technicians. Some schools will offer both trade and technical programs, usually limiting their technical programs to relatively few offerings. Some schools which are not in position to offer advanced technical work may offer the first year of a two-year technical program, with the student transferring for the work of the second year to a larger and better equipped school.

Area vocational schools of industrial type which offer programs of both trade and technical types are often called vocational-technical schools. When the school provides only training for highly skilled technicians it may take the title of technical institute.

The administrative patterns for area vocational schools vary widely. Some are administered and financed directly by the state. Some are organized on a county basis. Some are developed through cooperative action of several school districts--by formation of a unified district encompassing several school districts, or by other forms of cooperative effort. The area vocational schools of Connecticut are administered by the State Department of Education. Those in New Jersey are on the county basis. Illinois has several programs developed through combination of contiguous school districts. The patterns are influenced greatly by state-wide patterns of organization of schools as a whole, by the degree of industrialization of the state, by the extent of local programs of vocational education, by the density of population in the state, and by other factors. Each pattern appears to grow out of individual state needs.

Area vocational schools are not new; we have had them for many years. California Polytechnic Institute, which now offers degree programs as well as other technical programs, started as an area vocational school. The Alabama School of Trades, the State Trade Schools of Connecticut, the North Georgia Trade and Vocational School, the North Carolina Textile School, and many others, were in the field of area vocational education many years ago. Wisconsin has operated for several decades a system of vocational schools, under local and state boards for vocational education separate from those for general education, which serve the needs of the state as area schools.

Increasing interest in the development of area vocational schools has been evident during recent years. The American Vocational Association has done much to advance the idea of area vocational education and to aid in the passage of Federal legislation toward this end. Funds made available under Title VIII of the National Defense Education Act of 1958 are limited to programs of area vocational education type. Programs of area vocational education type under the Act include technical institutes, community colleges, technical high schools, etc., which serve areas beyond the local school district. An Area Vocational Education Branch was established in the Division of Vocational Education, U.S. Office of Education, to assist in the development of programs under this Act.

Stimulated by funds available under the National Defense Education Act, and by increasing state and local interest in this field, many new developments have occurred within recent years. Here are some of them, as outlined in a memorandum prepared by the Area Vocational Education Branch, Office of Education:

In Alabama, legislation has provided for construction of 3 additional state vocational schools which will admit students from a greater geographical area than that served by individual schools.

Arkansas established an area vocational school at Pine Bluff.

Connecticut has developed two new technical institutes, and two additional ones have been authorized. It also has 14 regional vocational-technical schools in operation.

Delaware opened a new area vocational-technical school in 1961, and funds have been appropriated for a second one.

Georgia has five new vocational-technical schools, and plans are under way for the ultimate development of 31 area schools.

Kentucky now operates fourteen vocational-technical schools, and fourteen more are expected to be built.

Louisiana operates 27 parish vocational schools of area type.

Minnesota opened a new area school in 1961, and three others are in various stages of planning and construction, in addition to the several area schools previously in operation.

Nebraska has provided funds for expansion of the state vocational-technical school at Milford, and plans to develop a second school.

New Hampshire has provided funds for the construction of a new technical institute, and approval has been given for three additional vocational-technical schools.

New Jersey has plans under way for the establishment of vocational-technical schools in three additional counties, and for the development of technical institutes in three counties.

New York has developed a long-range plan to provide additional area vocational education through expansion of the existing programs in the larger metropolitan areas, expand industrial-technical programs in the smaller cities to include suburban districts, and provide for needs in rural areas through a cooperative area plan.

North Carolina has developed a state-wide plan for area vocational-technical education through 20 centers, more than half of which are now in operation and the others in planning or construction stages.

Ohio has approved legislation for the development of area programs.

Oregon has passed legislation providing state aid in building four area vocational education centers.

South Carolina has provided funds for study of the needs of the state and for the establishment of new centers.

Tennessee plans to build six new area schools in various parts of the state.

West Virginia has made provision for developing area vocational programs in 31 counties, and proposals are being made for the development of 8 area vocational schools.

The Office of Education memorandum also indicates that several states which provide area vocational education through community colleges are expanding their programs. The report indicates widespread interest and activity in area vocational education.

Brief descriptions of three state-wide programs and their development may help to found out the picture of area vocational education; those in Connecticut, New Jersey and North Carolina.

Connecticut was one of the first states to develop organized vocational education on a comprehensive scale, with the establishment of its State Trade Schools in 1910. In the early days the students spent some 54 hours per week in school, and attended most of the calendar year. The instruction was largely confined to shop practice. After some years the program was altered to conform more nearly with the yearly calendar of the high schools, and the work week was shortened to 30 hours. The curriculum was modified to include more classwork. In 1947 the school title changed from "trade school" to "vocational-technical" school, and technical training was added to the program. Recently schools of technical institute type were developed, of a level and quality acceptable for E.C.P.D. accreditation of curriculums. The expansion of the technical programs is still actively under way.

The Connecticut schools from the beginning were administered by the State, with the exception of one school in New Haven which has recently come under State control. Students from anywhere in the State were eligible for admission, thus the schools met the criteria of area programs. The 14 present regional schools, together with the present and proposed technical institutes, provide fairly adequately for the needs of the State. Connecticut is a good example of the development of high quality technical institute education, growing out of a vocational-industrial school background.

New Jersey developed its large program of vocational education largely on the basis of county units, with separate boards for vocational education. In the 1920's the programs were largely of skilled crafts type, operated as trade schools. These developed into vocational high school type programs, and vocational-technical curriculums were added. At present, proposals are under way for the development of technical institute type curriculums. Enrollment in the county vocational schools is open to residents of the county, and to some from outside the county.

The county type of organization, where the initiative for the development of vocational education must come from within the county, leaves gaps in those geographical areas where county educational leadership does not choose to provide such education. New Jersey has had such gaps, some of which are now being filled in by the development of new programs. The considerable number of recent surveys of needs for technical workers, by New Jersey county vocational educators, is evidence of increasing interest in technician training.

North Carolina is an example of a different type of development of area vocational education. Until very recently the State has had relatively little vocational industrial education, carried on in the high schools, and in one state-operated textile school. It has one technical institute operated as a branch of North Carolina State College. Within the past five years a state-wide network of Industrial Education Centers has been developed, with more than half of them now in active operation, most of them in modern buildings. Skilled crafts and skilled specialty training predominate in these Centers, but substantial starts have been made in the direction of technical training. One Center now has a program of computer technology, with equipment which cost approximately $140,000.

Within the past two years the State Board of Education has worked with the North Carolina Employment Security Commission in planning a state-wide survey of technical and selected skilled occupations, which has since been completed. On the basis of the findings of this survey a state-wide master plan is now being developed, with curricular allocations based upon the findings of the occupational survey (43).

Buildings are provided by the county educational units; equipment and operating costs are largely provided by the State. Essentially the State Board of Education administers the program, in cooperation with the county boards. Students are admitted from wide areas. The organization pattern provides for "satellite" programs in counties adjoining those in which the Centers are located. Much excellent equipment has been provided through government surplus, and through funds available under the National Defense Education Act. Backed by the interest of manufacturers, many of whom have recently set up new plants in the State, the program appears to be moving ahead rapidly. In some respects the development of a state-wide program of area vocational education has been more rapid and far-reaching than in most other states.

Title VIII of the National Defense Education Act has had great influence on the development of area vocational programs. This is discussed in some detail in section 18 of this report.

11. TECHNICAL TRAINING IN THE HIGH SCHOOL

Each year a substantial number of persons enter work life in the technical field directly after completing a high school program of technical education. They may have come from a specialized technical school or from a comprehensive high school with a technical department. In either case they usually have completed a rigorous program, with substantial portions of mathematics, sciences and drawing. The curriculum they followed may have been a somewhat general one, with content from several technological fields, or it may have been one in which the technical content pertained to a single field. They usually enter industrial life on the lower levels of engineering technician occupations.

The objective of the technical high school program is two-fold: preparation for entrance to engineering college, and preparation for work life on the technician level. The well-planned school has separate curriculums for meeting these two objectives, a broad one for engineering college preparation, and a more specialized one for students whose objective is entrance upon work life immediately upon graduation. The college entrance curriculum provides the mathematics and science required for engineering college admission, and often includes foreign language. The vocational-technical curriculum includes the mathematics, science, and drawing required in the field of specialization, and a liberal portion of shop and laboratory activity pertinent to the specialized technical field. Both curriculums provide the usual courses in English, social studies, general science, and physical education required of all high school students.

Entrance standards in technical high school programs are high. Prospective students must show good records in arithmetic and elementary science, and have intellectual ability of 100 I.Q. or above. Some schools set 115 I.Q. as the desirable minimum, and may use entrance examinations in the selection process. The result is a student body of high grade.

The technical high school is not new in American education. Its development was influenced by the manual training schools operating at the turn of the century. Some of the older schools of technical high school type were Cass Technical High School of Detroit, Arsenal Technical High School of Indianapolis, Rindge Technical School of Cambridge, and Baltimore Polytechnic Institute (22). The State of New York has perhaps been the leader in the development of technical high schools. The first of these was started in Buffalo in 1904, and programs have developed since in more than 20 communities.

The New York State program of technical high school education has developed on a sound basis over these years. Under the leadership of a state supervisor of technical education, standards were set up, curriculums were developed, and comprehensive technical examinations on a state-wide basis were established. Strong emphasis was placed upon vocational-technical programs, designed to prepare youth for entrance into technical occupations, and geared to the needs of industry. Table XIII shows a sample curriculum recommended by the State Education Department.

TABLE XIII. VOCATIONAL-TECHNICAL CURRICULUM FOR METAL TRADES AND DRAFTING
(New York State Technical High Schools)

	Number of 45-minute periods per week
10th GRADE	
English	5
Health and physical education	5
Technical mathematics I and II	5
Mechanical science	5
Mechanical drawing	10
Machine shop	10
	40
11th GRADE	
English	5
Health education	2
Social studies	4
Technical mathematics III and IV	5
Technical science and laboratory	6
Mechanical drafting	10
Manufacturing practice	8
	40
12th GRADE	
English	4
Health education	2
American history, problems of democracy	4
Technical mathematics V and VI	4
Strength of materials, heat treatment, and metallurgy	6
Mechanical drafting and machine design	10
Manufacturing methods	10
	40

Technical high school programs in New York State are found in some of the smaller cities as well as the metropolitan centers. Some programs are operated as departments of comprehensive high schools. Sometimes the technical high school curriculums are operated alongside vocational curriculums in a vocational-technical school. In Buffalo and New York City separate technical schools are found. Brooklyn Technical High School, covering a large city block and eight stories high, has more than 7,000 students. Its laboratories, equipped with such items as metallography equipment, fatigue testing machines, and industrial X-ray machine, rival those of an engineering college.

The high entrance standards, the rigorous curriculum (requiring completion of 19 units as compared with the usual 15), the high quality of the instructional staff, and the singleness of purpose shown in the vocational-technical programs in New York State have resulted in graduates who are accepted readily by industrial establishments.

Dr. Joseph Nerden, chief of the technical education program in Connecticut, points out that the training of technicians on the secondary level is an industrial necessity, even though it is recognized that the task is a difficult one. The average high school graduate is rather immature to take on the important tasks of the technician immediately upon leaving school. Today the costs of mistakes in industry are high, and many employers prefer workers who have had post high school training. The work of the engineering technician has reached a level where two years of post high school training, or its equivalent, is almost a necessity.

The trend toward placing technician training in the years beyond the high school is unmistakable, but one can only guess as to how rapid the change will be. There are many levels of technical occupations, and perhaps some of the lower levels will continue to be open to high school graduates for some years to come. The high school may well continue to provide training for the technician field as long as graduates can be placed. If and when the time comes that the job opportunities no longer exist for high school graduates of technical programs, perhaps the role the high school should play would be that of appropriate pre-technical training, laying the foundations for effective specialized study in the post high school institutions.

12. EVENING AND PART-TIME TRAINING FOR TECHNICAL WORKERS

Most of the persons presently employed as technicians have entered their jobs through other means than full-time preemployment training programs. They have learned what was needed while working -- through self study, through correspondence study, and through organized courses made available outside their working hours.

In some ways the service rendered by technician training institutions through evening and other part-time classes is even more important than that provided for full-time students. Many thousands of workers are partially prepared for their jobs, and many more thousands aspire to jobs that require additional training. It is uneconomical and unwise for most of these persons to leave their jobs and undertake full-time study. They must get the training needed while they still are working. The programs offered by the training institutions in the evening, and at other times outside of working hours, make it possible for these persons to reach their desired goals.

Some of these persons need updating for their present jobs, to keep them in phase with changing technology. Some have gaps in their training background -- basic mathematics, science, and the like -- which they would like to fill. Some are interested in preparing themselves for work quite different from their present employment, and are willing to attend evening classes for several years, if necessary, to get the training needed. Some attend the part-time classes to prepare themselves for technical specialty jobs that require only short training programs. The range of needs is great, and a wide variety of educational offerings is required to meet these needs. This presents a real challenge to the technical training institution, and requires educational vision on the part of the school administrator far beyond that needed to operate only a full-time day training program.

The most effective institutions for the training of technicians, from the standpoint of total service rendered, are those located in industrialized urban areas within easy commuting reach of large numbers of employed workers who need this type of training. The part-time program of such institutions is large -- in scope of program and in numbers of students. <u>In the opinion of the writer, a really good technician training institution will have nearly as many student contact-hours in part-time classes as in the full-time day program</u>. Since evening students attend classes for shorter periods per week than do day students -- varying perhaps from 2 hours per week to 15 hours per week -- the total number of part-time students may thus be as high as four times the number of day students. Few institutions attain this ratio, yet the potential is present for those which really desire to meet the total training needs of the community.

If an institution is to meet a challenge of this sort, it must be properly located with respect to the industries employing technical workers. It must be served with adequate transportation facilities, including parking space for workers' cars. It must have up-to-date equipment for classroom, laboratory, and drafting room instruction. It must be an attractive place in which to study. It must have prestige in the community. And it must offer the kinds of courses that workers need, at hours in which they can and will attend.

The range of course offerings in evening classes may vary from short, intensive courses a few hours in length to curricular offerings paralleling those of the full-time day school and extending over several years. And it is interesting to note that workers with ambition will attend such long programs year after year, in substantial numbers. Some of the shorter courses duplicate portions of the day curriculums. Others deal with special content needed by a small group of workers, perhaps from a single plant.

The students in evening programs vary greatly in age and background. All of them are persons of sufficient maturity to know what they want, and there is little difficulty in motivating them in their study, when instructors are qualified in their subjects and their teaching methods. It is not unusual to find a course in calculus review for engineers in a classroom adjacent to one in basic principles of electronics, or a discussion group dealing with human relations in supervision. The students include skilled mechanics upgrading themselves to technician jobs, young workers in technical jobs aspiring to jobs of more advanced technician type, supervisors of technical processes studying to improve themselves in supervisory techniques, engineering technicians studying recent technological developments, young women preparing themselves as programmers for engineering data processing or as technical secretaries, and workers in fields entirely outside industry who are taking extended programs to get themselves ready for industrial technical jobs.

The problem of obtaining suitable instructors for evening classes is perhaps not quite as acute as for full-time programs. Many qualified engineers and technicians in industry like the opportunity of part-time teaching. They know their technical content,and if given help in the organization of instructional materials and in teaching methods, many of them make excellent teachers. And frequently such teachers tend to help the school keep up to date in its technological content in the day program. Instructors in the day school program usually are used for many of the evening classes. In the case of laboratory courses the day school teacher is preferred since he knows the laboratory facilities.

Evening programs of technical nature are offered in many types of schools: technical institutes, technical divisions of community colleges, extension programs of engineering colleges, technical divisions of area vocational-technical schools, training departments within industry.

University extension programs provide a considerable amount of training on the technician level through evening classes. During World War II the engineering colleges established a far-flung program of extension training on a rather wide range of levels and content. The courses were required to be of college grade, yet the program included a range from the theory of elasticity for graduate engineers to elementary blueprint reading. This program, known as the Engineering, Science, and Management War Training Program, operating from October 1940 until the end of June 1945, involved 227 colleges and universities and enrolled 1,796,000 students, largely in part-time classes (21). The total Federal expenditure was nearly $60 million. Under the supervision of the colleges and universities participating in the program, classes were held in many types of centers, including technical institutes and vocational schools. One interesting aspect of the program was that technical institutes which had operated for years as high grade institutions were not permitted to participate directly, but had to render their service as sub-contractors to a college or university even though the technical institute knew more about certain types of training included in the program than did the college under which it was a subcontractor. A summarized description of the ESMWT program is included in Office of Education Bulletin No. 228 (22).

Correspondence study plays an important part in the supplementary education of employed workers, especially in technical fields. The National Manpower Council in its publication "A Policy for Skilled Manpower" has this to say concerning correspondence instruction: (39)

> "For many years, a significant amount of technical instruction has been provided by correspondence schools. There are now some 300 private correspondence schools with estimated enrollment of about one million. Another 175,000 students are enrolled in correspondence courses given by university extension divisions. The forty-two schools accredited by the National Home Study Council account for about 80 percent of enrollment in private schools. Probably about 300,000 of these students are taking courses in the skilled and technical occupations."

> "The vocational and technical correspondence courses serve the same types of people who enroll in parallel evening courses -- young, ambitious workers seeking knowledge to qualify for promotion or to keep a new job. About 5,000 companies have contracts through which their employees may take at company expense either regular correspondence courses or specially developed courses. Because the larger schools have very large enrollments scattered all over the country, they are able to offer a great variety of courses, many not available in the residence schools of most localities."

It reports also an enrollment in 1954 of some 290,000 enlisted men and officers in the classroom and correspondence courses of the United States Armed Forces Institute, with approximately 30 percent of the men enrolled in courses of trade and technical type. More than one fourth of the men in technical courses indicated that they enrolled to prepare for civilian careers, but since the completion rate is about one in fifteen the number thus prepared for civilian employment is not large.

Elonka gives brief descriptions of the courses in instrumentation and process control offered in 15 institutions (15), with some of the courses based upon outlines prepared by an Education Committee Task Force of the Instrument Society of America.

The importance of correspondence instruction in technician training is recognized by the Engineers' Council for Professional Development. In its 1961 listing of accredited curriculums two correspondence study programs in electronic technology are included.

In 1953 McVean made a study of the evening programs of a considerable number of technical institutes and junior colleges, including a detailed study of the student body in the Institute of Applied Arts and Sciences at Binghamton, New York (31). This study of some 500 evening school students indicated that 13 percent had not completed high school, 42 percent were high school graduates, 28 percent had attended college one to three years, and 17 percent were college graduates. This indicates a wide range of educational background.

The age distribution of the students in the McVean study showed 24 percent under 26 years of age, 67 percent in the 26 to 39 year bracket, and 9 percent over 40 years of age. Only 20 percent of the students were unmarried. Sixty-one percent of the students lived within five miles of the school, and seven percent lived over 20 miles away.

The Pennsylvania State University recently surveyed the students in ten of its evening technical institutes. (14). Approximately 1,000 students were included in the study, three-quarters of them enrolled in technical courses which do not carry engineering college credit. Some 95 percent were high school graduates. Approximately 37 percent were over thirty years of age. Nearly 68 percent of these students indicated that they preferred an extended program covering several years, as compared with shorter courses in special subjects.

13. OPERATING PRACTICES IN POST HIGH SCHOOL TECHNICAL TRAINING PROGRAMS

This section deals with operating practices in institutions offering programs of technical institute type, including technical institutes, community colleges, technical institute divisions of universities, and area vocational-technical schools. It attempts to portray some of the highlights of program operation, such as curriculum patterns, accreditation, credentials awarded, student body, placement of graduates, plant and equipment, and operating costs. The discussion deals with broad aspects, covering the various types of institutions without specific reference to individual types, and is confined largely to programs which train engineering and industrial technicians, in full-time curriculums.

Curriculums for preemployment training of technicians.

The typical curriculum is two years in length, with courses which total some 70 semester hours of credit. It is designed to meet the needs of a student who has completed high school, has taken appropriate high school courses in mathematics and science, has aptitude for the occupational field served by the curriculum, and who has intellectual ability equal to or above that of the average high school graduate. It includes courses in basic and applied mathematics, science, and graphic arts; and courses in the major field of technology and in related fields. It usually includes some courses in general education. The instruction is provided in classrooms, drafting rooms, laboratories and shops. Emphasis is placed on laboratory instruction; the development of shop skills is a minor objective.

The curriculum usually has fixed course requirements, with few electives. Sometimes two or more specialized types of curriculums are arranged with a common first year, and the student has an optional second-year program, as is often found in electrical and electronics curriculums. In contrast with engineering curriculums in which the first year is devoted largely to basic mathematics and science, the technical institute type curriculum introduces the student to the technology of his selected field early in his program.

Within the framework of the general characteristics noted above, one finds considerable variation in curriculums in a specific field in different institutions. Roney's analysis of 32 curriculums in electrical, electronic, and mechanical technology in 25 post high school institutions, shown in Table XIV(60), reveal some of these variations.

TABLE XIV. ANALYSIS OF 32 SELECTED CURRICULUMS IN ELECTRICAL, ELECTRONIC, AND MECHANICAL TECHNOLOGY

Curriculum division	Semester-hour requirement			
	Range		Mean	
	Minimum	Maximum	Hours	Percent of total
Technical specialty courses -- Basic and advanced courses in the technology-----	19	47	35	49
Mathematics courses -- Algebra, trigonometry, analytic geometry, calculus----------	5	20	9	13
Science courses -- Physics, chemistry, mechanics, hydraulics, thermodynamics, etc.	3	22	9	13
Auxiliary and supporting technical courses-- Mechanical drawing(general), shop, technical report writing---------------------------	4	21	7	10
General education courses - Communications, humanities, social studies, health---------	2	24	11	15
Total -----------------	62	80	71	100

Henninger's analysis of ECPD-accredited curriculums for 1957, shown on page 66, uses a slightly different breakdown, but indicates content distribution quite similar to that of Roney.

The total hours spent by the student per week in school and in study usually is approximately three times the number of credit hours for the semester. Thus a curriculum with 16 semester-hours credit would require about 48 hours of work from the student. The basis for calculating the total hours required is to allow two hours of study for each hour in the classroom, and none for the work in the laboratory. If the laboratory work is of such nature that outside time is required for writing up the results of laboratory tests, the basis for credit may well be one unit for each two hours in the laboratory assuming that one hour of outside work would be needed.

One of the problems faced in reviewing curriculums is the great range of titles for courses dealing with similar content. In mathematics, for example, one finds such titles as basic technical mathematics, engineering mathematics, industrial mathematics, applied mathematics, electrical mathematics, and the like, in addition to the more common titles such as algebra or trigonometry. Meier's analysis of course titles in electrical and electronic technology, and his plea for consistency emphasize this problem (33), as does Mitchell's criticism

of the Meier article. (38). Course titles in the technical institute field have not accepted the standardization that is found in engineering curriculums, and perhaps the nature of technician training may never permit them to do so.

Standardization of curriculums as a whole likewise has not made much headway in the field of technician training, and perhaps this, too, has some justification. Yet when one considers that the placement market for graduates of technical institute curriculums is nationwide, a case can be made for more standardization than we have at present. Some States, such as Wisconsin, are taking steps toward standardization through their accrediting programs. When we reach the stage of certification of technicians, as is done in Canada with the cooperation of the Engineering Institute of Canada, we shall need to give more attention to standardization of curriculums.

The amount and types of general education in the curriculum of the technical institute are subjects that have given rise to much discussion. Some persons feel that the aim of the technical institute should be largely limited to that of meeting the needs of industry for technicians with adequate technical skills. Others feel that all educational institutions have to think of the student as a whole person, and that he should have opportunity to develop the non-technical side as well as the technical one. Beatty states that technical institute type programs two years in length do not have the time available to provide for formal courses in the humanities without seriously reducing the vocational competence of the graduates (6). His program in mechanical technology at Wentworth Institute includes some 7 percent of the total credit hours in this field. In contrast, the curriculums in the institutes in New York State surveyed by Booher provide a percentage range of general education from 15.5 to 32 percent, with an average of 20.3 percent. (8).

The curriculum builder is faced with a dilemma. If too much general education is included, students will not enroll. If too little is provided, the student may be deprived of education that may be very useful to him as a person during his lifetime. When the writer of this report was serving as consultant in the planning of the institutes for New York State, he entered upon the task with the desire to hold down the general education content to the lowest possible minimum. Before the three-year task was finished he wondered whether the program pattern provided for enough to really meet the total needs of the student.

The amount of mathematics needed in the technician training curriculum has also been the subject of considerable discussion. Some feel that unless the curriculum includes the calculus it does not meet the needs of the technician, and some appear to feel that the mark of respectability of a curriculum depends upon its presence. Many technicians who work closely with engineers and scientists, especially in such fields as electronics, may need to use the calculus in their daily work. Many other technicians find little, if any, direct use for it. Some of the basic principles of the calculus may be useful or necessary in the teaching of certain aspects of science and technology. In such case it functions in the same manner as does scaffolding in the erection of a building, no longer needed when the building is finished. The sensible approach would seem to be to provide as much mathematics, of the proper type, as is really needed

in the occupational fields for which students are being trained, and to determine this through thorough analysis of the duties of the occupations.

Curriculums are developed in a number of ways, by patterning them after other curriculums, by building them on the basis of analysis of the occupations, and the like. The pattern of the curriculum often is influenced by the background of the curriculum builder. If his background is largely of community college type, there is a tendency to follow the community college broad content pattern and to include perhaps more of general education, in types of courses given to other community college students, than is found in the average curriculum. If the program is under the aegis of an engineering college, there is some tendency to follow the course pattern of that institution. If developed by a group with vocational-industrial education background, the tendency is to pattern the curriculum after that of the vocational-industrial school where the shop activities comprise the core, and the mathematics, science and technology are related to the shop work.

The activity analysis approach to curriculum building, developed to high degree at the Rochester Institute of Technology, is one of the best methods of curriculum construction, especially in new occupational fields. In this method, clusters or groups of closely related occupations are worked out as the occupational goals of the curriculum. The occupations in these clusters are analyzed for curriculum content, and appropriate courses are developed from these analyses. Basic and applied mathematics and science courses are added, together with appropriate general education courses, and the whole is arranged in organized fashion. This approach to curriculum building is outlined in "Technician Training Beyond the High School" (16), and developed in considerable detail in "A Guide to the Development of Programs for the Institutes of Applied Arts and Sciences" (66). The procedures in using job factor comparisons for clusters of occupations are described in "Suggested Techniques for Determining Courses of Study - Electrical and Electronic Technology" (56), and the similar bulletin for Mechanical Technology Design and Production (59).

Accreditation of programs.

Accreditation of technical training programs by agencies which have State or national recognition is of value to the institution, the community which supports it, and to the student. Accreditation sets standards for the institution, and measures it against these standards. Items such as the program of studies, objectives of the program, requirements for admission, requirements for graduation, library, physical plant, faculty, and administration, are appraised and evaluated in terms of the standards. Accreditation is a prestige factor, valuable in student recruitment and in the placement of graduates.

Accreditation is provided by legal bodies or voluntary organizations. It may be on a state-wide, regional or national basis. It may deal with the institution as a whole or with individual curriculums. Accreditation of higher institutions on a regional basis is done through the New England, Middle States, Southern, North Central, Northwest, and Western accrediting associations. The standards of these agencies are described in Chapter 4 of "American Junior Colleges - 1960" (1). Jenkins provides a good description of accrediting practices for junior colleges, including State and regional agencies (28). The Engineers' Council for Professional Development accreditation of technical institute type curriculums is discussed on pages 63-65 of this report.

State accreditation of training programs is sometimes done by State agencies concerned with licensing of workers, for example, nurses or cosmetologists. Or it may be done by State departments of education. Wisconsin has taken a forward-looking step in the accrediting of technical institute type curriculums in its vocational and adult schools. The State Board for Vocational Education has set up standards and procedures for such accreditation, and has established criteria for such specific programs as architectural technology, electrical technology, automotive technology, and business administration (68).

Accreditation of an institution as a whole is a different matter from accreditation of a specific curriculum. In the latter case more specific criteria are necessary, and the appraisal should be made by a committee competent in the specific field. So we shall probably need both types. As technical education grows in numbers of students, and in diversity of types and levels of offerings it may be desirable to consider ways and means for providing regional and national accreditation for other phases of technical education than the engineering technician type now accredited by E.C.P.D., including technical training in agriculture, health fields, and the like, and programs for technical specialists in the industrial field.

Recognition of Graduation - Types of Awards.

Graduates of technical training programs may be awarded a certificate, diploma, associate degree or some other formal award. The associate degree is the most common type, awarded in 70 percent of the engineering-related curriculums reported in "Organized Occupational Curriculums" (61). This bulletin provides the data for Tables XV and XVI showing types of awards offered, by institutions and by curriculums.

TABLE XV. NUMBER OF INSTITUTIONS OFFERING ORGANIZED OCCUPATIONAL CURRICULUMS, BY TYPE OF AWARD OFFERED, 1958. (61)

Number of institutions with organized occupational curriculums leading to:	Number	Percent of total (767 institutions)
Associate in arts	228	29.7
Associate in science	86	11.2
Associate in applied science	68	8.9
Associate in business	28	3.7
Associate in commerce	23	3.0
Associate in education	10	1.3
Associate in engineering	17	2.2
Other associate degrees	19	2.5
Certificate or diploma	479	62.5
Other awards	26	3.4

NOTE: Some institutions grant more than one type of award.

TABLE XVI. NUMBER OF ENGINEERING-RELATED CURRICULAR OFFERINGS, BY TYPE OF AWARD, 1958 (61)

Engineering-related curriculums	Number of curriculums	Number of curriculums leading to: Associate's degree	Number of curriculums leading to: Other award	Percentage leading to associate's degree
Aeronautical	39	24	15	61.5
Air conditioning, heating and refrigeration	34	21	13	61.8
Architectural and civil	145	101	44	69.7
Chemical	40	32	8	80.0
Electrical	243	170	73	70.0
General engineering technology	77	58	19	75.3
Industrial	54	44	10	81.5
Mechanical	275	194	81	70.5
Metallurgical	13	9	4	69.2
Miscellaneous	85	52	33	61.2
Total	1,005	705	300	70.1

The practice of awarding the associate's degree appears to be increasing. In comparison with the 70.1 percent of the total curriculums in which the associate degree was awarded in 1958, from the previous table, the comparable figure for 1957 was 65.8 percent.

Costs of Technical Education

The cost of technical education on the semiprofessional level approaches that for engineering training. Laboratory equipment is expensive and becomes obsolete quickly. Institutions operating technical training programs have to compete with salaries paid in industry in order to obtain and hold qualified teachers. Laboratories require many square feet of area. The physical plant has to be constructed to meet the many special requirements of technical instruction.

In the Illinois study of vocational and technical education (65) McLure gathered data on physical plant, capital outlay, and operating costs of technical education in comprehensive type junior colleges and in technical institutes. He indicates the trend in planning for 1,000 to 3,000 full-time student enrollments requires minimum sites of from 60 to 120 acres. Building costs at 1958 prices are cited as from $13 to $17 per square foot depending upon design, regional differences in prices, and other factors. From the data in Table XVII, gathered for the study, he indicates the minimum cost per full-time student for capital outlay at $3,000 at 1958 prices.

TABLE XVII. CAPITAL OUTLAY COSTS OF COMPREHENSIVE TYPE JUNIOR COLLEGES (65) (1958 Prices)

Junior College	Cost per full-time student	Full-time student capacity
California junior colleges (recently built):		
American River	$ 2,370	2,671
Antelope Valley	3,038	2,086
Bakersfield	3,447	3,430
Cerritos	3,309	3,970
Chaffey	2,414	2,920
Coalinga	3,868	723
ElCamino	2,744	4,360
Reedley	3,996	830
Santa Ana	2,387	1,961
Sierra	3,903	991
New York:		
Erie County Technical Institute	2,590	3,000
Broome Technical Community College	3,000	1,000
Average	3,072	

Henninger comments on the capital outlay for technical institutes in New York State as follows (26):

> "Although the specific costs vary among these institutions, experience over a period of years has led to a general formula for projecting capital costs for new construction. To develop a new campus from the ground up, the per capita cost is figured at $4,000. Thus on this basis a campus fully equipped and ready to operate to accommodate 1,000 students would represent a capital cost of approximately $4,000,000."

Comparative data on operating costs for technical instruction are somewhat difficult to obtain due to differences in cost keeping methods in different types of institutions. Some useful data have been obtained, however, in recent studies. McLure gathered operating cost data from institutions in Illinois, California and New York (65). Current expense per full-time student enrolled for the year 1957-58, is reported by him as follows:

Institution	Current expense per full-time student enrolled
Illinois:	$ 737
Chicago	938
Joliet	
California:	782
American River	900
Fresno City	647
Sacramento	890
San Diego	689
Los Angeles Junior College of Business	1,194
Los Angeles Trade-Technical Junior College	606
Fullerton	872
Bakersfield	
New York:	1,200
Broome Technical Community College	760
Erie County Technical Institute	574
Hudson Valley Community College	902
Westchester Community College	
Average	835

Data on operating costs gathered by Henninger (26) from some 95 institutions offering programs either accredited by E.C.P.D. or considered as reasonably equivalent showed wide variations. Seven tax-supported institutions showed a range of from $212 to $1440 operating cost per student year year, with a mean of $837. Thirty-five junior colleges with technical divisions showed costs ranging from $131 to $1449 per student per year, with a mean of $495. Data are also shown for private institutions and for divisions of colleges and universities.

It is interesting to see such a wide range in costs as indicated in the data from the Henninger survey. It is hard to understand how a program equal to those with E.C.P.D. accreditation could be operated at a cost as low as $131. On the other hand, costs as high as $1449 would imply specially costly types of programs, or location in a community with high salary schedules.

Salaries of instructional staff make up a substantial portion of the operating budget of a technical program, perhaps 60 percent. A recent study of salary ranges in technical institutes made by Carson (10) reported data, from 21 technical institutes with E.C.P.D. approved programs, on salaries for the current year, 1961-62, summarized as follows:

	Annual salaries (1961-62)	
Rank	Range	Average
Instructors	$3,600 - 7,250	$5,430
Assistant professors	4,770 - 9,200	6,380
Associate professors	5,580 -10,500	7,436
Professors	6,300 -12,010	8,451

From the data available it would appear that $800 per year per full-time student could be used safely in estimating operating costs for post high school technical programs of good quality.

New construction in recent years has added considerable capacity to the technical training programs of the country. Here are some of the new developments:

Hartford State Technical Institute, Connecticut, has recently built a new plant with 55,000 square feet of floor space to provide for 400 full-time students, including 9 laboratories, 6 classrooms, two lecture rooms, and 5 drafting areas.

Norwalk State Technical Institute, Connecticut, started instruction in its new plant in 1961. Construction for new institutes at Norwich and Waterbury is under way, and plans are being drawn for two more institutes in the State.

Broome Technical Community College, Binghamton, N.Y., recently completed a $3,000,000 plant on a campus of 49 acres, and is adding lecture rooms to increase its capacity to 1500 full-time students.

New York State Agricultural and Technical Institute, Farmingdale, added modern facilities for its industrial-technical division a few years ago, and is now adding a radioisotope laboratory.

Hudson Valley Community College, Troy, N.Y., dedicated its new $3½ million campus in 1961.

Mohawk Valley Technical Institute, Utica, N.Y., moved to its 80 acre campus and $4½ million plant, with 200,000 square feet of floor space, in 1961.

Roanoke Technical Institute, Roanoke, Virginia, dedicated its new plant in 1961, with 35,000 square feet of floor space costing about $500,000, and some $400,000 in equipment.

Southern Technical Institute moved from Chamblee, Georgia, to its new 118 acre campus at Marietta.

Wentworth Institute, Boston, is adding some 6,000 square feet of floor space in a new nuclear science building.

North Carolina has recently built several new Industrial Education Centers, some of which will offer technical training, such as the Centers of Burlington, Charlotte, Asheville, and Durham.

Many other new plants have recently been built or are under way in other parts of the country.

14. STUDENT POTENTIAL FOR TECHNICAL TRAINING PROGRAMS

If one were developing a post high school program of technical training for an underdeveloped country which had relatively few young persons attending secondary schools, one would have to review carefully the numbers actually in secondary schools, the numbers of graduates annually, and the potential growth in secondary education. In the United States, however, such a study would not need to be extensive, and might not need to be made at all except when planning post high school facilities to serve a specific geographical area where the high school enrollment might not be large.

Many studies have been made of what happens to the high school graduate. Out of these studies have come the general conclusions that large numbers of them enter the labor market without further schooling, and that a great many of them have the ability to pursue higher education effectively. Many of them might carry through successfully a four-year college curriculum. Many others would be able to achieve success in occupational training programs of two years beyond the high school.

The President's Commission of Higher Education reported in 1947 its conclusion that at least 49 percent of our population has the mental ability to complete 14 years of schooling with a curriculum of general and vocational studies that should lead either to gainful employment or to further study at a more advanced level, and that at least 32 percent of our population has the mental ability to complete an advanced liberal or specialized professional education. (45). Based upon this conclusion, one-sixth of the youth of college age -- 18 to 21 years -- would be capable of doing satisfactory work at the junior college level. If appropriate facilities were available, with diversified curriculums appropriate to their needs, a large proportion of these students would pursue occupational training programs.

Some 1.5 million students were graduated from high schools in 1960. If one-sixth of these graduates had entered higher education programs for which they had aptitude and ability, the new students entering such programs each year would number some 250,000 students. If one could use a retention rate of 60% for the second year of a two-year program, frequently attained in occupational curriculums, the total enrollment in the two-year institutions would be approximately 400,000 students.

Data gathered on enrollment in organized occupational curriculums two years in length for 1959 (61) showed full-time enrollments of 42,000 students in engineering-related curriculums and 97,000 in nonengineering-related curriculums, a total of some 139,000 students. The increase from 1958 to 1959 was about 10,000 students.

The basis of projection used above -- one-sixth of the high school graduates as capable of completing two years of study beyond high school - no doubt includes students who attend junior college transfer courses and don't do well enough to be accepted at the third-year level of college study, as well as students who enroll in occupational curriculums. As the projection ratio was based upon the abilities of the population as a whole, and many students are not able to complete high school, the ratio for high school graduates might well be a bit higher. The data on enrollments in organized occupational curriculums exclude many students enrolled in post high school training programs located in institutions not listed as higher educational institutions in the Office of Education directory which furnished the list for gathering the data reported above. Taking all these factors into account it appears quite definite that enrollments fall far short of the potential of 400,000 students. With a projected high school graduation list of some 2.2 millions for 1970, the projected number would amount to some 590,000 potential students in two-year post high school curriculums in 1970. Recent growth in full-time enrollments in organized occupational curriculums has been approximately 10,000 per year.

The previous discussion has dealt with potential for full-time programs, and has not considered the numbers of students who attend on a part-time basis or who enroll for special short extension courses. In comparing the enrollments of community colleges, for example, with the student potential, one must be careful to compare like items. The total enrollments reported for these institutions usually include large proportions of part-time and special students.

Growth in post high school program enrollments has been considerable, yet it appears that its rate will have to be increased to meet the needs of the oncoming hordes of young people graduating from high school in the years immediately ahead, as well as the increasing demands from employed workers.

In making estimates of student potential from numbers of high school graduates, one must keep in mind that half the high school graduates are girls, and if they are to be attracted to post high school programs, the programs must be in keeping with their needs. They now make up a substantial portion of the enrollments in business courses, and are entering the engineering-related curriculums in increasing numbers. Technological change is creating new technical jobs in which women can find ready employment. Data processing is an example, and many women will be employed as programmers and in other capacities in the years ahead. If the total needs of industry for technical workers are to be met, it is probable that women will need to enter occupations which formerly were handled largely by men. The recent bulletin of the Women's Bureau on careers for women as technicians outlines many of these opportunities (64).

If students are to be attracted to post high school occupational training programs, certain present difficulties must be minimized. Here are some of the blocks that inhibit students from continuing their formal education, as outlined by the President's Committee on Education Beyond the High School (44):

1. Lack of information about careers in time to prepare for them.
2. Lack of self-knowledge of individual capacities.
3. Lack of inspiration at home and in school.
4. Failure of the student to see the relationship of further schooling to his career needs or to the realization of his full potentital.
5. Negative family attitudes.
6. Labor market conditions which make it attractive to enter the labor force early.
7. Lack of facilities for post high school education and training in the local community.
8. Lack of personal or family funds for tuition and support.
9. Inability or unwillingness of the family to give up the earning capacity of the youth.
10. In some cases, discriminatory practices in admissions, after admission, and in employment after graduation; in some cases, misconceptions which lead to student discouragement.
11. Breaks in the educational continuum(military service, marriage, leaving school for a job, etc.), without ready opportunities to reenter school, even though the individual later realizes that additional education would be desirable.

Some of these inhibiting factors are beyond the scope of the educational system which provides the training; others can be alleviated somewhat by appropriate action within the schools. Guidance counselors might be prepared better for dealing with students whose needs and desires lie outside the four-year college. Facilities might be brought within the geographic reach of the potential student, or measures provided to ease the burden if the curriculum needed is at some distance. Tuition-free institutions attract the most students in this field; but if tuition must be charged, scholarships to help needy, worthy students might be provided. Attractive school environments, modern equipment, good faculties, well-developed curriculums, and effective placement service for graduates all have bearing. The prestige of the school in the community is of considerable importance.

The changing geography of industry in America has bearing on student potential. Areas which formerly were largely range and farmlands now are dotted with modern industrial plants. New patterns of education are needed for these areas, and youth in these areas are becoming more conscious of careers in industry.

If educational programs of appropriate types on the post high school level can be brought within reach of youth, if the programs can be operated under such conditions as will make it possible financially for youth to attend, and if effective programs of publicity can be developed to acquaint youth and their famililties with the opportunities which these programs provide, it appears evident to the writer that students can be recruited in sufficient numbers to fill the programs.

Discussion thus far has centered on student potential for preemployment programs. What is the situation with respect to student potential for part-time programs? In a good technical school of post secondary level, properly located, the part-time students may well greatly outnumber the full-time students. Today as many technicians prepare themselves for their jobs through part-time study as come from full-time curriculums. Workers undertake part-time study to upgrade themselves in their present jobs, or prepare themselves for new and better jobs. If properly motivated they will attend classes several evenings per week over long periods of time. But certain conditions need to be met if such students are attracted to a school. The course offerings must meet their needs, in content, level, and methods of instruction. The instructors must know their fields thoroughly. The physical plant must be attractive, and the equipment up to date. The school must be within easy commuting distance from where the workers are employed or where they live. Parking space must be available for student cars.

The overall potential for part-time and evening classes in the post high school institution located in a highly industrialized area is very large. Rapid technological change brings about new needs for technical education on the part of industrial workers. Some of these needs are met by in-plant training programs. But many of them will be met only if appropriate programs are offered by technical training institutions.

Over the years, the evening programs in the skilled crafts fields which were subsidized from Federal funds, limited the enrollment to employed persons, and the courses pursued had to be supplementary to their daily employment. Under Title VIII of N.D.E.A. there is no such limitation in the training of technicians. Evening classes may enroll qualified students in preemployment training programs, as well as in supplementary extension classes. This opens the student potential of the evening and other part-time programs to a wide scope. Enrolled in such programs are workers of all technical levels upgrading themselves in their present jobs, industrial workers preparing themselves for new technical jobs, and workers in fields outside industry who pursue programs which prepare them for technical jobs within industry.

The student potential for evening technical training programs in fields outside industry -- especially the business field -- is also large. The institution which provides a wide range of evening school programs in all pertinent fields has great opportunity for helping meet the technical training needs of its whole community.

15. ORGANIZATIONS AND AGENCIES CONCERNED WITH TECHNICAL EDUCATION

The overview of semiprofessional technical education would not be complete without some reference to the many agencies and organizations that are concerned with this field directly or indirectly. The group includes educational associations, professional societies, trade organizations, manpower councils, Federal agencies, Presidential committees, and others. This section lists a number of these organizations and agencies, and gives a brief summary of some of their activities.

Educational associations directly concerned with technical education.

A small number of educational associations have very definite interests in the training of technicians and other technical workers. Among these are the American Association of Junior Colleges, the American Society for Engineering Education, the American Society of Training Directors, the American Technical Education Association, the American Vocational Association, the National Council of Technical Schools, and the National Home Study Council.

The American Association of Junior Colleges has some 500 institutional members and more than 100 individual members. (1). It was organized in 1921, with some 70 schools represented. Through its five research and service commissions it deals with administration, curriculum, instruction, legislation, and student personnel. It publishes the Junior College Journal. In line with the growth of occupational training in the junior/community colleges, the Association has become increasingly interested in various phases of occupational training, including technical education. Large numbers of students are presently enrolled in technical programs in the institutions represented by the Association.

The American Society for Engineering Education is primarily concerned with the training of engineers, but within recent years its activities have expanded to include the training of engineering technicians. The original Society for the Promotion of Engineering Education, from which the present society emerged, made the first important study of technician education -- The Study of Technical Institutes -- which is described in some detail in section 2 of this report. The Technical Institute Division of the Society held its first meeting in 1941, and since that time it has been active in the development of technician training. Its activities have included the sponsorship of the national survey of technical institute education in 1957-1958, reported as "The Technical Institute in America" (26). Underway at the present time is the evaluation study of technical institute education. The meetings of the Division are held as a part of the annual A.S.E.E. convention.

Through its committees on teacher training and recruitment, relations with industry, curriculum development, relations with educational organizations, and relations with government agencies, the Division carries on research and promotional activities in many aspects of the training of engineering technicians.

The American Society of Training Directors deals with the many facets of training within industry, from vestibule courses to extended management development programs. Although concerned with technical training as one phase of its wide range of programs, the Society has not been as active as some of the other associations in promoting its development.

The American Technical Education Association in its early years was concerned mainly with the technical high school. In recent years its activities have broadened to include technical education of post high school level as well. Its executive secretary is active in sending out reprints of miscellaneous articles on technical education, and a bi-monthly newsletter. The annual meeting of the Association is held with that of the American Vocational Association. Committees are at work on recruitment and education of teachers, standards for technical education in high school, and standards for post high school technical education.

The American Vocational Association embraces all fields of vocational education -- including agriculture, industry, distributive occupations, business, and home making -- and has been most active in those areas of vocational education which have been subsidized under the Federal vocational education acts. It is concerned with keeping its membership informed about developments in the various fields of vocational education, with helping to interpret vocational education, and with promoting its development through legislation and otherwise. In recent years it has been active in promoting the area-type vocational school. Several committees are at work. Under the leadership of the Committee of Research and Publications, several bulletins have been developed, including a comprehensive one on area vocational education programs (2). The Association publishes the American Vocational Journal. Over its more than 50 years of existence the American Vocational Association has done much to promote the interests of public vocational education, and has exerted much influence on its development.

The National Council on Technical Schools was organized in 1944, to improve the status of private schools offering resident programs for the training of technicians. It is not a large organization but several of its leaders have wielded considerable influence in the field of technical institute education.

The National Home Study Council sets standards for correspondence study schools, many of which offer programs in technical subjects.

In addition to the foregoing educational associations of national scope which are concerned with technical education are the State and local educational groups, such as the State vocational education associations. Increasing interest in technical education on the part of the State vocational education associations has developed in recent years, especially since Federal aid for the training of technicians was added to the George-Barden Act by the passage of Title VIII of the National Defense Education Act. A significant development was the recent organization of the Oklahoma Technical Society, designed to further the development of technical education in that State. It publishes the Journal of Technology.

In his bulletin on "Engineering and Scientific Manpower," Armsby describes in some detail the activities of 30 agencies having to do with this field (4). Of these, nearly half have some interest in technician training, either directly or through the relationship of technicians as supporting personnel to engineers and scientists.

The Engineering Manpower Commission, organized in 1950 by the Engineers' Joint Council, helps to inform the public of the importance of engineering in the national economy, aids in promoting the training of engineers, and promotes effective utilization of engineers in industry. It makes surveys and publishes reports, including a 1958 study of Technical Institute Enrollment.

The Engineers' Council for Professional Development has as one of its functions the evaluation of engineering college and technical institute curriculums and their accreditation. It publishes an annual list of accredited curriculums for training engineering technicians. Further description of the accrediting program is found in section 8.

The National Association of Manufacturers has published and distributed widely a guidance bulletin entitled "Your Opportunities as a Technician."

The National Manpower Council was established at Columbia University in 1951, under a grant from the Ford Foundation, to study manpower problems and aid in the development and utilization of manpower. It has published several books, such as "A Policy for Skilled Manpower," "Improving the Work Skills of the Nation," and "Womanpower." Their publications contain considerable material which has bearing on technician training.

The National Society of Professional Engineers, a membership organization of registered professional engineers, has been active in promoting the development of technician training, and in the utilization of technicians to relieve professional engineers from having to perform non-professional tasks.

Federal Agencies Concerned with Technician Training

Many Federal agencies have interest in, or direct relationships with, technical training of semiprofessional type. Among these are the following:

The Atomic Energy Commission assists educational institutions in planning programs in the nuclear field, and conducts specialized courses for reactor supervisors and courses in the techniques of using radioisotopes.

The Civil Service Commission is concerned with the recruitment and utilization of technicians in the many branches of government which employ such workers, and in the development of job qualifications and specifications for technician occupations.

The Department of Defense has much to do with respect to the training and utilization of technical personnel in military and civilian occupations within the Department. Descriptions of some of the activities are found in section 5.

The Department of Health, Education, and Welfare is closely related to the field of technical education, especially in the Office of Education. This Office compiles statistics on technical education on all levels, makes contracts for research, administers the National Defense Education Act of 1958 and the previous vocational education acts, and performs various services in promoting the development of technical education. The operation of Title VIII of the National Defense Education Act is described in section 18.

The Department of Labor has many contacts with the employment of technicians and their training. The Bureau of Employment Security and affiliated State employment security agencies make studies of technician employment, develop and administer tests for selection of students for technical training, provide labor market information, and deal with placement of technical workers on jobs. Work is under way in developing a section of the Dictionary of Occupational Titles dealing with technician occupations. State Commissions for Employment Security in many cases work closely with educational authorities in the development of training programs and in the making of occupational surveys. The Bureau of Labor Statistics makes major studies of the employment of manpower, often under contract with agencies such as the National Science Foundation. It regularly gathers statistics on employment and unemployment. It publishes the "Occupational Outlook Quarterly" and the "Occupational Outlook Handbook," which contains much information on technician occupations. Information from some of the recent BLS studies of demand for scientific and technical manpower is shown in section 2. The Women's Bureau has recently published a bulletin on women technicians (64). The Bureau of Apprenticeship is concerned with apprenticeable occupations of technical character, and the rising technical needs of skilled crafts workers.

The Federal Communications Commission is concerned with the supply of trained technicians available for meeting its needs in such fields as electronics communication.

The National Aeronautics and Space Administration is concerned with the fullest utilization of professional personnel through the development of supporting technician staff with breadth and intensity of technical competence, in its own operations and the work of the contractors who supply equipment.

The National Science Foundation sponsors summer institutes for upgrading mathematics and science teachers at secondary and higher levels, including teachers in technical institutes. It has also sponsored extensive surveys made by the Bureau of Labor Statistics which included data on technician employment forecasts.

The Office of Civil and Defense Mobilization is concerned with technicians as one facet of the national supply of manpower available in national emergencies, and through its regional conferences has been gathering extensive data on availability of technicians and industrial needs in this field.

Industrial Organizations Concerned with Technician Training

Many industrial groups have undertaken or sponsored various activities pertaining to the development of technicians. Here are brief descriptions of a few of the many such activities:

The Radio-Electronics-Television Manufacturers Association (now the Electronic Industries Association) has been active since 1952 in supplying technical schools with manuals and training aids, and carried out a pilot course for testing materials developed for television servicing. In 1956 it carried out a survey of some 90 member firms dealing with a quantitative analysis of practices within the electronics industry aimed at alleviating shortage of engineering, scientific and technical personnel. The survey included data on training programs conducted by the companies, gifts of equipment to schools offering technical programs, and measures used by the companies in encouraging young people to undertake scientific and technical study.

The Foundation for Instrumentation and Research has been active in promoting technical training in the instrument field, and has sponsored summer institutes for the training of instructors.

The Instrument Society of America, through its Task Force on Instrumentation Technicians, made a national survey during 1959 and 1960 of the functions performed by instrumentation technicians (27). The report contains considerable detail on these functions.

The American Petroleum Institute has been concerned for many years with the development of instructional materials dealing with the production and refining of petroleum, and with cooperating in the operation of training programs in this field.

Many other industrial organizations have been active in assisting in the development of technical training programs or in operating courses of their own. Among these are the Oil Institute of America, the National Hardwood Lumber Association, the Fluid Power Society, the National Machine Accountants Association, the National Office Management Association, the American Society of Tool Engineers, the American Foundrymen's Society, to mention only a few.

The education of technicians and other technical personnel impinges on the work of many agencies. The Administration for International Development uses many technicians in its foreign service program, and its programs of aid to underdeveloped countries include assistance in the development of technical training programs. The Peace Corps needs technicians, and is interested in their development.

16. RESEARCH IN TECHNICAL EDUCATION

The place and importance of research in the field of technical education need to be recognized more widely, and steps need to be taken to develop research commensurate with the needs of the field. In this era of rapid technological change many things are happening that affect technical education. New scientific concepts are emerging. New materials and processes are appearing in industry. New instruments, machines, and process controls are replacing older ones. Occupations are changing rapidly. Industries are moving into new geographical areas. Significant changes are taking place in the age, characteristics, and spread of the population. These, and other changes, affect technical education.

If technical education is to meet the needs for training in this rapidly changing world, it must adapt itself to the changing conditions. Its patterns of organization must fit into the evolving educational structure of the nation. Its curriculum content must be in line with technological and social needs. Its methods of instruction must be in keeping with the latest and best understanding of how people learn and how they can be taught most effectively. If technical education programs expect to provide adequately for the needs of a state or of the nation as a whole, much more information is needed than is now available. If specific programs are to be effective and efficient, more must be learned than we now know. This is the task of research -- on a broad scale, from specific studies of detail problems to nation-wide studies of problems involving the country as a whole.

The research in semiprofessional technical education which has been done to date might be described in terms such as the following:

1. Much of the research in this field has been applied research, dealing with such subjects as occupational and educational surveys, curriculum and course-of-study development, evaluation of local programs, and the like. Some attention has been given to large-scale occupational and educational surveys, and to cooperative efforts in developing evaluative criteria, but the number of large studies has been small.

2. Comparatively little attention has been given to basic research in the sciences and other disciplines which underlie technical education, and their influences and impacts on this field. Little has been done concerning the psychology of learning technical skills, motivation in learning situations, how desirable work habits may be developed, critical aspects of instructional materials that affect learning, and the like. There has been little experimental research under controlled conditions.

3. A considerable amount of research in technical education has been superficial, with little depth or penetration. The gathering and classification of the data have absorbed so much energy that little has been left for reflective thinking about the meaning and import of the data, and for the drawing of conclusions that are meaningful.

4. There has been relatively little research which has pooled the resources of the different disciplines that have bearing on technical education. Most of it has been done by educators who often did not have adequate understanding of the contribution that might have been made by well-qualified psychologists, sociologists, economists, employment specialists, and others, whose experience and understanding might have given greater insight into the research problems.

5. Dissemination of the results of research in technical education has been inadequate, with no centralized agency or medium through which interested persons might learn the results of the researches without a great deal of effort.

It is understandable why research in technical education has followed the pattern outlined above. Research is a specialized professional task. It requires adequately trained professional personnel, backed up by adequate research assistants, library facilities, computing equipment, graphic arts service, clerical help, and the like. Facilities for controlled experimentation are needed for certain types of studies. Interview surveys in depth, and extensive case study projects, require trained personnel working over considerable periods of time. Really good research demands a favorable research atmosphere, and most projects require considerable financial outlay.

A few comprehensive studies -- especially occupational and educational surveys -- have been adequately financed and carried out well. The Bureau of Labor Statistics occupational studies, some of the occupational surveys made by State Employment Security Commissions, and some of the educational and occupational surveys made with financial aid from Title VIII of N.D.E.A., have been reasonably broad in scope and carried out well. But perhaps all of the organizations concerned with these studies wished that they had had more funds and more time for their projects. Some of the studies financed by grants from foundations -- such as the studies carried out by the American Society of Engineering Education -- have provided valuable results.

Outside of these few large studies, much of the research in technical education has taken the form of relatively small projects undertaken by graduate students and faculty in university schools of education. Very few of these studies have been made under the Cooperative Research Program of the

U.S. Office of Education. The scope and quality of studies made by technical educators have been limited by such factors as the following:

1. Very few schools of education have had faculty members who were qualified in the field of technical education.

2. Most technical educators are employed for administering or supervising programs of technical education, or teaching in technical schools. They are practical-minded persons, interested mainly in the tasks for which they are held responsible. A few of them have some interest in research, but they usually undertake research projects only when faced with a problem that requires applied research, or when a research project is required as one facet of a program of advanced study which they may be pursuing.

3. Technical educators have shied away from really tough research jobs which demand a great deal of time, energy and reflective thinking. Few persons in the field of technical education are truly research minded, and have the time and resources for extended research projects.

4. Much of the research in technical education grows out of the requirements for advanced degrees. Requirements for the master's degree can often be met by minor studies rather than real research, and usually the facilities required and financial aid needed for extensive studies are lacking. Doctoral dissertations involve more extended research projects, but many of these are quite limited in scope and depth. Many persons who carry out research projects as part of their professional study lose interest in research as soon as the degree is awarded.

5. Too few persons in the field of technical education take enough graduate work of appropriate type to prepare them for good research. Most graduate students don't go beyond the master's degree. Many who continue through the doctorate pursue the Doctor of Education degree, which generally emphasizes research much less than does the Doctor of Philosophy degree.

6. University professors in the field of technical education, who might be expected to carry on research themselves, are often so loaded with teaching and other duties that there is little time and energy left for research. Often the available time beyond the teaching schedule, which might be used for research, is utilized for outside paid consulting service to supplement low salaries. Many of these professors prefer to teach rather than to do research.

7. Research if well done costs money, and often funds have not been available to carry the financial burden.

Prior to the past decade relatively little is found in the literature concerning research projects in the field of technical education of semi-professional level. The S.P.E.E. Study of Technical Institutes (1931), and the Office of Education study of Vocational-Technical Training for Industrial Occupations (1944) were studies of considerable magnitude. In 1945, Leo Smith of Rochester Institute of Technology started his annual survey of technical institute enrollments, recently taken over by the U.S. Office of Education and continued in its annual study of Organized Occupational Curriculums.

In recent years a considerable number of research projects dealing with various aspects of technical education -- some large and some small -- have been reported. Among these are the following, many of which are listed in the bibliography at the end of this report:

Occupational surveys, by the Bureau of Labor Statistics in cooperation with the National Science Foundation, and by State Empl. ment Security Commissions in such states as Arizona, North Carolina, and Utah.

Studies of technical workers in special fields, such as the BLS studies of the atomic energy field, and the mobility of electronic technicians.

Occupational and educational surveys, such as those by the Florida State Education Department, the Kansas State Board for Vocational Education, the Texas A and M College System, the Los Angeles City School District, the Kansas City (Missouri) School District, the Syracuse (New York) Board of Education, the vocational school boards of New Jersey county systems, and State Education Departments in Illinois and Oregon.

Studies of curriculum development in electrical, electronics, and mechanical technology and in data processing; studies of job relationships in electrical and mechanical fields; study of occupational criteria and curriculum patterns; and annotated bibliography of materials in the field of technical education, by the Division of Vocational Education, U.S. Office of Education.

Follow-up surveys of graduates of Southern Technical Institute and New York State Agricultural and Technical Institute of Farmingdale.

Studies of evening schools and evening school students in the Penn State extension centers and in the Binghamton technical institute.

The recent A.S.E.E. study of technical institute education.

Survey of tasks performed by instrumentation technicians by the Instrument Society of America.

Manpower studies by the National Manpower Council and the President's Committee on Scientists and Engineers.

The above listing is not at all complete, but shows some of the important recent contributions. Underway are such projects as the A.S.E.E. study of evaluative criteria, the technician supplements to the Dictionary of Occupational Titles, and the informal gathering of valuable data on technical personnel needs through the regional conferences held by the Office of Civilian and Defense Mobilization.

All these studies have helped materially in the planning of further development in semiprofessional technical education. Yet much more needs to be done in the field of technical education research. Here are some examples of questions pertaining to technical education for which answers are needed:

1. What technical occupations, of different levels, are found in fields such as the following, and how many workers are employed and needed in these occupations?

   Maintenance and service occupations in manufacturing establishments, consumer technical service, etc.

   Agricultural occupations, and occupations in business and industry directly related to agriculture.

   Medical and health fields.

   Business fields -- wholesale and retail merchandising, banking, insurance, real estate, etc.

2. What are the nation-wide needs for technical workers, broken down into occupational groupings small enough to be usable for planning training programs, that should be met by preemployment programs in schools?

3. To what extent are women employed in technical occupations, and in what capacities? How do their qualifications and their performance compare with those of men in similar positions?

4. To what extent is it practicable to classify technical workers into groups such as "engineering technicians?" What groupings, if any, should be used? What criteria should be used to distinguish one group from another?

5. How did present-day technical workers receive the training needed for their jobs? What are the occupational "ladders" to technical positions?

6. What contribution to military service is made (or could be made) by pre-induction technical training? What types and levels of training are desirable? What contribution to the civilian industrial economy is made by military technical schooling and military experience?

7. What differences are found between large and small industrial establishments with respect to the preemployment training desired for persons entering technical employment in specific fields?

8. What are the types and levels of extension programs desired by workers employed in technical occupations, broken down by subject groupings small enough to provide bases for planning such programs? What is the relative demand for the different types of programs?

9. What are the strengths and weaknesses of placing preemployment technical training on the high school level as compared with the post high school level? Under what conditions is training feasible on each level? What kinds of entry jobs are secured by graduates of each type of program, and what is their relative success in industry?

10. What educational administrative patterns of post high school preemployment technical training are best suited to meet training needs of specific occupational groups -- separate technical institutes, technical institutes operating as divisions of engineering colleges, community colleges, area vocational-technical schools? What are the trends with respect to present-day expansion of these types of schools? Are they in the right direction?

11. What are the strengths and weaknesses of providing technical training in the same institution which offers training for the skilled trades?

12. Is standardization of institution titles desirable? To what extent do present titles indicate the training provided in the institutions?

13. To what extent is standardization of curriculum titles, and of curriculum content, desirable for post high school preemployment programs?

14. What are optimum lengths for specific types of preemployment curriculums - in time? in credit hours?

15. What are the strengths and weaknesses of a common first-year curriculum for all technical students in a two-year post high school institution that provides offerings in several technologies?

16. What is the most desirable type of curriculum for training technical writers, technical salesmen, and the like, whose jobs cut across other fields besides industrial technology?

17. What are the qualifications necessary for success as a technical teacher, or an administrator of a technical school, and how can these be assured by appropriate certification requirements?

18. What are optimum sizes for class and laboratory groups in specific courses in technical education?

19. What objective criteria should be used in the selection of laboratory equipment, textbooks and reference materials, and other instructional aids in technical training?

20. What motivates a student to learn technical skills? What frustrations impede his learning? How can these factors be utilized in the teaching process?

21. How effective is programmed learning as compared with usual teaching practices?

22. What are the most effective ways of developing analytical ability in technical situations, resourcefulness, creativeness, teamwork, and the like, in technical school settings?

23. What are the most effective methods and devices for the selection of students for preemployment technical training programs?

24. How well acquainted with semiprofessional technical education are counselors in the high schools of the nation, and what are their attitudes toward such training?

25. What criteria can be utilized to evaluate the effectiveness of technical training programs, and how can they be used effectively?

26. What is the historical development of semiprofessional technical education in America, and in what directions is it moving?

These are some of the questions that need to be answered if technical education of semiprofessional type is to attain the effectiveness it should have. The answers to some of these questions will require long and expensive research projects. Some of the other questions might be answered by studies of lesser stature. The kind of research needed to reach the answers will require trained research personnel, research facilities, time, money, and effort. Large industrial organizations and several Federal governmental agencies have considered research important enough to spend millions of dollars in search for answers to important questions. Appropriate research, well planned and well carried out, is an investment and not just an expense. In the long run the returns far exceed the costs.

The writer of this report feels that appropriate research in the field of technical education is one of the most important tasks that lie immediately ahead in this field. Even though millions of dollars may be appropriated for expansion of present forms of technical education, the long-term results will not be as effective as would be the case if sensible amounts of money were provided for research designed to guide the expansion. What measures might be taken to further research in the technical education field? Here are some suggestions:

1. That closer working relationships be established between educational agencies (Federal and state) and agencies concerned with manpower needs, such as departments of labor and manpower councils, in the furthering of studies of manpower needs.

2. That the Office of Education continue and expand its work in gathering and disseminating data on technical education in the United States, on both secondary and post high school levels, with greater breakdown of data than have hitherto been made available.

3. That the Office of Education stimulate greater participation in technical education research projects under the Cooperative Research Program.

4. That university schools of education continue, and expand, the research conducted by faculty members and graduate students. in technical education.

5. That specific provision be made for research in technical education in Federal legislation which may be enacted for aid to technical education.

6. That the Office of Education contract with one or more universities for the establishment and operation of a research center or centers devoted to the task of research in industrial and technical education.

Item No. 6 may need some amplification. The proposal envisions a large-scale attack on research problems in industrial and technical education, in a center designed for this purpose, adequately financed, with freedom to operate in much the same manner as the contract agencies financed by the various branches of the Armed Forces. Among the specific suggestions for this proposal are the following:

a) That a research institute for industrial and technical education be established as a distinct branch or unit of a university recognized for scholarship and research.

b) That the institute concern itself wholly with research, and be concerned with graduate study only as it might serve as a place of interneship for graduate students who were majoring in research and were qualified with respect to research procedures.

c) That the research institute be permitted by the University to operate under its own regulations with respect to staff titles, staff salaries, purchasing, etc., consistent with broad University policies yet with considerable independence with respect to operating procedures.

d) That the research institute be financed by Federal appropriation under a long-term contract with the Department of Health, Education, and Welfare.

e) That the research projects undertaken grow out of important needs in the field of industrial and technical education, suggested by the U.S. Office of Education or discovered through other sources.

f) That the overall program of the research institute include:

   1) Basic research as well as applied research.

   2) Development of experimental programs in industrial and technical education growing out of the research, trying out such programs in suitable industrial and technical training institutions, and evaluating the results.

   3) Publishing the findings of its research and development work.

g) That the research institute have close working relationships with appropriate divisions of the U.S. Office of Education.

h) That the first research institute be located relatively close to or in Washington, D.C., to permit access to library facilities in the Office of Education and elsewhere.

The proposed research institute should be provided with suitable housing, adequate professional and research assistance staff, and supporting services of library, editorial, graphic arts, and clerical types. The professional staff should include research persons from the various disciplines that impinge on industrial and technical education -- psychology, sociology, economics, occupational analysis, personnel service in industry, and the like, working together on an operation research organization pattern. The initial staff might well include six or eight professional research persons, with supporting staff proportionately large.

It is believed that a project of the type outlined above would produce research results that would be very valuable to industrial and technical educators concerned with the development and operation of training programs, and that it would stimulate research by other educational agencies and in other fields of educational service.

17. TECHNICAL AND OTHER SEMIPROFESSIONAL EDUCATION IN FIELDS OUTSIDE INDUSTRY

The presentation of technician training in this report has been largely confined to engineering-related technical occupations, found mostly within industry. But there are many occupations of a type and level comparable to those of engineering technicians in such fields as agriculture, business, government, medicine and health, as well as similar occupations that cut across two or more of these fields. Many of these occupations require persons with backgrounds in appropriate science and technology, different from that needed by the engineering technician but of a similar level and quality. Some of these occupations are of managerial type. Some persons would prefer to use some other designation than "technician" for most of these jobs, but irrespective of their labels they deserve attention in any far-reaching program of occupational education.

The range of curriculum offerings which provide training for these occupations is reasonably wide. Here are some of the occupational titles and the fields covered in these curriculums:

<u>Agriculture</u>:

Agriculture - general
Animal husbandry
Dairy products manufacture
Elevator and farm supply
Farm equipment sales and service
Floriculture
Forestry
Horticulture
Poultry husbandry
Nursery and landscape management

<u>Business</u>:

Accounting
Banking
Business data processing
Executive assisting
Hotel management
Insurance adjusting
Office machines operation
Purchasing
Real estate and insurance
Restaurant management
Retail merchandising
Secretarial - general
Secretarial - legal
Secretarial - medical
Technical office assistant
Transportation and traffic management

Graphic Arts:

Advertising design and production
Graphic arts management
Photography
Technical illustration

Medicine and Health:

Biological laboratory worker
Dental assistant
Dental hygiene
Dental laboratory technician
Medical technician
Medical X-ray technician
Nursing
Public health technician

Miscellaneous:

Costume design
Fire protection
Laundry and dry cleaning
Library work
Police methods

Relatively few institutions now provide training programs in agricultural technology. Some are found in agricultural and technical institutes, such as those of New York State. Some are offered by land-grant colleges. In his article on such programs offered by Michigan State University (25), Henneman describes curriculums in elevator and farm supply, farm equipment sales and service, nursery and landscape management, and commercial floriculture. He shows a breakdown of curriculum content as outlined in Table XVIII.

TABLE XVIII. CURRICULUM CONTENT IN AGRICULTURAL TECHNICIAN TRAINING
(Michigan State University)

Subject area	Curriculum			
	Elevator	Farm Equipment	Nursery	Floriculture
Business --------	30%	24%	18%	14-23%
General --------	12	16	14	13
Basic science ---	24	18	21	14-23
Technical---------	34%	42%	47%	50

These data indicate a relatively high proportion of technical content needed in all these occupations.

Training programs in the field of business account for a high proportion of the enrollments in post high school nonengineering related curriculums. Until recent years the private schools of business provided most of this type of training. The recent growth of occupational curriculums in community colleges has provided increased training opportunities in the business field. With the introduction into business offices of much new equipment, some of it rather complicated, the training needed by workers in the upper levels of business occupations is demanding increased technical competency. This is especially true in offices which utilize data processing equipment of the more modern types.

Occupational demands for technical workers in the field of medicine and health appear to be increasing, and large numbers are now enrolled in training programs in these fields.

Data on enrollments in organized occupational curriculums of nonengineering related type, two years but less than four years in length, in two-year colleges and four-year colleges and universities, are gathered annually by the U.S. Office of Education. Table XIX shows the enrollments in 1958, by occupational groups. Most of these enrollments are in curriculums classified as of technician level.

TABLE XIX. ENROLLMENT IN 1958 IN NONENGINEERING RELATED ORGANIZED OCCUPATIONAL CURRICULUMS OF TWO OR MORE BUT LESS THAN FOUR YEARS, IN HIGHER EDUCATION INSTITUTIONS

	Number of institutions	Enrollment in full-time courses - October 1958
AGRICULTURE AND FORESTRY		
Agriculture, general	77	1,857
Agriculture, industrial	7	303
Animal and poultry husbandry	19	725
Dairy technology	16	207
Floriculture and horticulture	21	440
Forestry	16	435
Landscape architecture	3	128
		4,095
APPLIED AND GRAPHIC ARTS		
Commercial art and advertising	54	1,543
Fashion design	16	630
Graphic arts	20	587
Interior decorating	15	161
Jewelry design	1	6
Music	35	342
Other fine and applied arts	31	485
Photography	15	215
Publishing and printing management	6	347
Publishing and printing technology	16	158
		4,474

TABLE XIX. (Continued)

	Number of institutions	Enrollment
BUSINESS AND COMMERCE		
Accounting	164	6,007
Business, general	272	12,961
Cosmetology	15	515
Executive assistant	9	164
Hotel management	6	340
Journalism	17	163
Radio and TV program production	18	319
Real estate and insurance	21	599
Retail sales or merchandising	82	2,236
Secretarial, general	445	16,436
Secretarial, legal	19	501
Secretarial, medical and dental	86	2,204
Secretarial, technical	9	377
Technical office assistant	2	19
Transportation and office management	17	82
		42,923
EDUCATION	173	12,104
HEALTH SERVICE		
Dental hygiene	34	1,903
Dental laboratory technology	8	292
Food inspection technology	1	34
Medical office assistant	14	575
Medical/biological laboratory work	66	1,024
Nursing, 2-year programs	39	1,674
Nursing, 3-year programs	43	4,079
Nursing, practical	2	92
Sanitation	2	16
X-ray technology	22	304
		9,993
HOME ECONOMICS		
Home economics or homemaking	83	1,359
Clothing and textiles	16	174
Food administration	15	457
Nutrition technology	3	65
		2,055

TABLE XIX. (Continued)	Number of institutions	Enrollment
MISCELLANEOUS		
Bible study or religious work	38	2,845
Fire protection technology	3	18
Library work	6	26
Mortuary science	5	201
Police methods technology	24	856
Safety technology	1	2
Other	15	184
		4,132
TOTALS - TECHNICIAN LEVEL:		79,776
Public institutions	350	49,193
Private institutions	342	30,583
CRAFTSMAN-CLERICAL LEVEL:		
Public institutions	12	1,205
Private institutions	4	59

Data from "Organized Occupational Curriculums in Higher Education," U.S. Office of Education.

In addition to the total of nearly 80,000 enrollment shown in Table XIX in full-time organized occupational curriculums two and three years in length, the report shows enrollments in full-time one-year programs of nearly 8,500 students, and part-time enrollments of approximately 42,000 students. The data are from 767 two-year and four-year institutions, listed in the U.S. Office of Education Directory of Higher Education, which reported organized occupational curriculums.

It is probable that considerable numbers of students, in addition to those reported above, are enrolled in similar curriculums in institutions which offer programs of post high school level but are not listed as higher education institutions. In the field of cosmetology, for example, State licensing requirements usually prescribe curriculum content and length of training. A considerable amount of such training is given to high school graduates. Table XIX shows 15 schools with total enrollment in 1958 of 515 students, yet in one State alone (North Carolina) more than 800 new licenses are issued annually, with the basic training given largely in some 50 private schools.

Over the years, the field of business education has received relatively little attention in legislation providing Federal aid to vocational education. It was excluded in the Smith-Hughes Act (except for continuation school students), and is included in the George-Barden Act only in the form of distributive education on a cooperative education or extension basis. This appears to be discrimination against business education. The situation probably developed because it was thought that the preparation of persons for business occupations was already provided for adequately by high school commercial curriculums and by the numerous private schools of proprietary type.

The National Defense Education Act - Title VIII provides Federal funds for the training of highly skilled technicians needed for the national defense, and may encompass training in other fields besides industry if defense needs can be substantiated. If Federal legislation for occupational training on the technician level is to be broadened to meet the needs of the whole economy, and the needs of all types of qualified youth in the nation, the expansion should take into consideration the fields outlined in this section.

18. TITLE VIII OF THE NATIONAL DEFENSE EDUCATION ACT AND ITS OPERATION

Interest in technical education on the part of the Division of Vocational Education, U.S. Office of Education, dates back a considerable number of years. The report of the study made by the Consulting Committee on Vocational-Technical Training (22) called attention to the needs in 1944. In the years immediately preceding the enactment of the N.D.E.A., the Trade and Industrial Education Branch put forth much effort in arousing interest in technical education. A national conference devoted to this subject was held in Washington, and regional conferences in Asbury Park, Memphis, Milwaukee, Ogden and San Francisco. It published reports of these conferences, a source book and discussion guide on vocational-technical education, and a bulletin that included a brief description of technician occupations and technician training together with an annotated bibliography (17). This work on the part of the Trade and Industrial Education Branch helped greatly in laying foundations in the States for their later efforts under Title VIII.

The idea of area vocational schools started early in the history of public industrial education, and received impetus in recent years through the activities of the U.S. Office of Education and the American Vocational Association. Several States had taken action in this direction, and had planned or put into operation state-wide area school programs. Some of these States had developed their area programs only recently; others had programs of many years standing.

The possibility of Federal aid for technical training was of concern to educators already engaged in the training of technicians in technical institutes and other types of institutions operating technical institute type programs. The needs of technical training for the national defense effort provided the setting for enactment of legislation which combined the idea of area vocational schools with the training of technicians. The National Defense Education Act was approved in September 1958. The Act contains several Titles dealing with other phases of educational effort needed in connection with national defense. Title VIII of the Act provides for the training of technicians.

The legislation provided that Title VIII of the NDEA take the form of an amendment to the Vocational Education Act of 1946 (the George-Barden Act), and it became Title III of that Act. The general provisions of the George-Barden Act thus control the Area Vocational Education Programs of Title VIII. The statement of findings and purpose of Title VIII is as follows:

"The Congress hereby finds that the excellent programs of vocational education, which States have established and are carrying on with the assistance provided by the Federal Government under the Smith-Hughes Vocational Education Act and the Vocational Education Act of 1946 (the George-Barden Act), need extension to provide vocational education to residents of areas inadequately served and also to meet national defense requirements for personnel equipped to render skilled assistance in fields particularly affected by scientific and technological developments. It is therefore the purpose of this title to provide assistance to the States so that they may improve their vocational education programs through area vocational education programs approved by State boards of vocational education as providing vocational and related technical training and retraining for youths, adults, and older persons, including related instruction for apprentices, designed to fit them for useful employment as technicians or skilled workers in scientific or technical fields."

Provisions of the Act include the following:

Authorization of $15,000,000 for the fiscal year 1959, and for each of the three succeeding fiscal years. (This was later amended to add two additional years to the life of the Act.)

Apportionment of the funds to the States on the same basis as the totals for Title I of the George-Barden Act, which allocates the authorized fund as follows:

$10 million for agriculture based on farm population
8 million for home economics based on rural population
8 million for trades and industry based on nonfarm population
2½ million for distributive occupations based on total population

Reallotment to other States of funds that States cannot utilize.

Matching of Federal funds by equal amounts of State or local funds, or both.

Funds appropriated under the Title shall be used exclusively for the training of individuals designed to fit them for useful employment as highly skilled technicians in recognized occupations requiring scientific knowledge, as determined by the State board for the State, in fields necessary for the national defense.

Funds may be used for:

1) Maintenance of adequate programs of administration, supervision, and teacher training.
2) Salaries and necessary traveling expenses of State or local school personnel, including teachers, coordinators, supervisors, vocational guidance counselors, teacher trainers, directors, administrators, and others.
3) Travel expenses of members of advisory committees or State boards.
4) Purchase, rental, or other acquisition, and maintenance and repair, of instructional equipment.
5) Purchase of instructional supplies and teaching aids.
6) Necessary costs of transportation of students.
7) Securing necessary educational information and data as a basis for the proper development of area vocational education programs and programs of vocational guidance.
8) Training and work-experience training programs for out-of-school youths.
9) Related instruction for apprentices.
10) Determining the need for, and planning and developing, area vocational education programs.

Amendment of State plans to provide for designating the State Board for Vocational Education as the sole agency for administration of the programs, for minimum qualifications of staff, and for other measures pertinent to carrying out the program such as accounting and reporting.

Defining "area vocational education program" as "a program consisting of one or more less-than-college-grade courses conducted under public supervision and control and on an organized, systematic class basis, which is designed to fit individuals for useful employment as technicians or skilled workers in recognized occupations requiring scientific or technical knowledge, and which is made available to residents of the State or a portion thereof designated and approved by the State board, who either have completed junior high school or, regardless of their school credits, are at least sixteen years of age and can reasonably be expected to profit by the instruction offered."

Regulations governing the administration of programs under Title VIII of the NDEA were developed by the Office of Education with the assistance of the General Counsel of the Department of Health, Education, and Welfare, approved by the Commissioner and the Secretary, and published in the Federal Register (55). When so registered, these regulations have a status similar to law. The regulations for Title VIII make reference to the regulations for the administration of the George-Barden Act (53), as well as providing new sections. Among the regulations are the following:

The State plan is to set forth the standards and procedures which the State Board will use in approving area vocational education programs. Such standards and procedures are to show how the following minimum criteria will be implemented:

a) There is need in the employment market for persons trained in the occupation for which the training is provided.

b) The content of the courses for which funds may be used has been determined by competent persons on the basisof an analysis of the occupation or cluster of occupations.

c) Those enrolled in the program have the necessary general educational background to benefit from the vocational instruction given in the program, and to fit them for the occupation for which the training is being given, or such necessary general education, including scientific education, is available to those enrolled as part of their total curriculum.

d) The program is of sufficient duration and there is sufficient time devoted to the technical courses in the curriculum to fit those enrolled for employment.

e) Classrooms, shop and laboratory facilities, including instructional equipment and supplies for effective instruction are to be available.

f) Personnel with professional and technical preparation and experience are to be employed as instructors and supervisors.

g) A system of student selection based on interests, aptitudes, previous education and work experience is to be maintained.

The State plan is to set forth the procedures and criteria to be used by the State board in determining which programs meet the requirements of the Act.

a) Extension (supplementary) courses which are designed for employed persons, including journeymen, to obtain additional training in the direct application of specialized functional aspects of science, mathematics and advanced technical skills and information required to meet the demands for highly skilled technicians in recognized occupations because of new and changing technologies. Such instruction may be organized to provide the required related instruction for apprentices.

b) Preparatory (preemployment) courses which are designed to prepare persons for useful employment to meet the demands for highly skilled technicians in recognized occupations(and not for training persons for a skilled trade) which requires the direct application of specialized functional aspects of science, mathematics, and advanced technical skills and information.

Occupations for which training may be given are those which have a significant number employed, or for which an overall shortage exists or is developing, and are found: a) in the design, development, testing, manufacture, processing, construction, installation, operation, maintenance, repair or servicing of plant facilities, equipment or products (or parts or accessories thereof) which are of importance for military or other defense activity: b) in providing technical services.

The industry or activity in which the occupation occurs is necessary to the defense program, such as: the military; suppliers of products or services to the military; suppliers of products or services directly connected with defense; and scientific research.

Among the rules and regulations pertaining to the George-Barden Act, and applicable to Title VIII programs is the following statement pertaining to the instruction permitted under the Title:

> Less than college grade. The State plan is required to provide that all vocational instruction carried on thereunder will be of less than college grade. This provision can be met at the adult or post 12th grade level only when all of the following conditions exist:
>
> a) The course is terminal in nature rather than directed toward obtaining a baccalaureate degree.
>
> b) The fact that the course is "of less than college grade" as here defined is discernible from the institution's catalog or other announcement describing the course.
>
> c) The course, (1) if offered by an institution which does not have a four-year program leading to a baccalaureate degree, is not designated by the institution for credit toward such a degree nor applied for credit toward such a degree as indicated by transfer policies of four-year degree granting institutions; or (2) if offered in a four-year degree granting institution, is not offered for credit leading to a baccalaureate degree.

The October-November 1958 issue of School Life is given over to a description of the various titles of the National Defense Education Act, and includes a table of allotments to the States for the total authorization for Title VIII ($15,000,000) and the initial appropriation ($3,750,000). Arnold's article in School Life, January 1960, provides an overview of Title VIII and its initial development (5).

Developments in Getting the Title VIII Program Under Way.

Many steps had to be taken before the Title VIII program could get into operation. The responsibility for the administration of the program on the Federal level was placed in the Division of Vocational Education of the U.S. Office of Education. The first task of this Division was the development of the regulations to govern the Title. Based upon the intent of Congress as expressed in the Act, the General Counsel of the Department of Health, Education, and Welfare together with the Assistant Commissioner for Vocational Education worked out the various regulations, for publication in the Federal Register.

One of the difficult tasks in interpreting the Act was a seeming conflict in wording of different portions of the Act with respect to whether skilled trades training might be included. In the statement of findings and purpose it appeared that "skilled workers" might be included as well as "technicians." A later section, however, limited the appropriation to training persons as "highly skilled technicians," and this was construed as the controlling purpose.

Early in the planning of the Title VIII program Assistant Commissioner Pearson insisted on programs with high standards, that hewed to the line of the intent of the Act. He called in consultants to help in outlining desirable practices for the programs, held conferences with chief State school officers and with State directors of vocational education, and met with representatives of the Armed Forces, and other groups. He established an Area Vocational Education Branch within the Division of Vocational Education to deal with Title VIII administration, and took steps to staff that Branch with qualified personnel. This took time, and by late spring of 1959 the first regular staff members went to work. The director of the Branch, Dr. Walter Arnold, started work in June 1959. A part-time consultant worked steadily with Mr. Pearson in gathering preliminary data and in helping with the planning during the first year of operation.

The long years of experience in administering the programs of vocational education under the Smith-Hughes and George-Barden Acts proved to be valuable in getting the new program off to a good start, and even though the specialized personnel in the Area Vocational Education Branch were not at work until late in the first year, the program went ahead under the direct leadership of Mr. Pearson and his associate Mr. Beard. State boards for vocational education were provided with information, State plans were reviewed, allotments were authorized, questions raised by the States were answered.

State Programs in Operation under Title VIII.

Many difficulties were encountered in getting programs under way in the States. There was lack of understanding of technical education on the part of the personnel in many State education department divisions of vocational education. State funds were not available for matching purposes in many States, and State legislatures were not in session to take action on approval of State participation in the Act. The States had to set up their administrative procedures and appoint staff members to deal with the new program. Some States designated present staff members; others recruited new staff for the program.

In getting the new program started the States had to develop curriculums and courses, secure equipment, and locate qualified instructors. In the initial period the first programs to get into operation were extension courses, which were more easily organized than preemployment programs.

During the first year of operation considerable amounts of money were used in making occupational and educational surveys concerning needs for technical education, and in the purchase of equipment.

The administrative patterns of the area programs within the States varied considerably. Some States concentrated on programs in the junior/community colleges. Some utilized their area vocational schools and their city high schools which had vocational education programs. Within a single State different types of institutional patterns were utilized. The extent of usage of these different facilities is shown in the tables of enrollments later in this section.

The following excerpts from a report prepared by the Area Vocational Education Branch, U.S. Office of Education in January 1962 give an overall picture of accomplishments to date.

"Recent studies pertaining to Title VIII programs emphasize the need not only for larger numbers of highly skilled technicians to support engineers and scientists but also for technicians with an ever-increasing knowledge of scientific and mathematical principles and their applications. Need for improvement in the quality of instruction in our technical education institutions is clearly indicated in order that the United States maintain its position of world technological leadership. Reports from the States disclosed that vocational educators are concerned with improving the quality of instruction in Title VIII programs. Greater emphasis is being placed on the depth and rigor of the curriculums required to prepare personnel needed to support engineers and scientists.

"A total of 1933 programs were approved by the State boards for vocational education and conducted in eight different general types of institutions during fiscal year 1961. Quality technical education programs, however, were not dependent upon the type of institution but upon strict observance of fundamental requirements for sound technical education, such as rigorous balanced curriculums with emphasis on mathematics and science concepts; competent technical instructors; able students; and well-equipped shops and laboratories. The following types of institutions conducted programs during fiscal year 1961:

Comprehensive high schools	168
Area Vocational-Technical Schools	66
Technical high schools	49
Vocational or Trade schools	106
Technical Institutes	25
Community or Junior Colleges	176
4-year Colleges or Universities	17
State boards for vocational education and others	13
Total..............	620

"Provisional figures, subject to final review of State reports, show a total of 122,952 persons enrolled in 1933 programs and courses for the training of technicians under Title VIII, an increase of 21 percent from 1960. Approximately 39,224, persons were enrolled in 732 preparatory programs and 83,728 in 1,201 extension programs.

"New programs reported in 1961 include nucleonics, plastics, and optics. Electronics with 49 percent of the total enrollment continues to be the most popular field, with mechanical programs, including drafting and design, ranking second with 24 percent of the totals.

"The first group of technicians was graduated from 2-year preparatory Title VIII programs in June of this year and the States indicate that their services are in great demand by industry. Reports received to date from 28 States indicate that the average wage rate for those graduates who were placed in the technical field for which they were trained was $4,600 (ranging from a low of $3,750 to a high of $7,336) for graduates of 2-year post high school programs, and $3,990 (ranging from a low of $3,000 to a high of $6,500) for those who graduated from high schools.

"Analysis of these reports shows that, of a total of 5,259 graduates, 3,808 were available for employment. 895 (17%) continued their education and 466 (9%) joined the Armed Forces. Of the 3,808 available for placement, 2,858 (76%) were placed in the technical field for which they were trained; 304 (7%) in a technical field related to their training; and 254 (6.5%) in a field not directly related to their training. Only 92 (3.5%) were unemployed at the time of the study, and 308 (7%) were unaccounted for. In addition to the graduates, one State reports that 600 of their students were placed before they graduated in data processing occupations.

"Boise Junior College has standing offers from the Hanford atomic installation for the graduates of the Mechanical Drafting and Design program. Industries in the Southwest are competing for graduates of the electronic program on the campus of Highlands University in Las Vegas, New Mexico. Graduates of the Highway Technology program at the Vermont Agricultural and Technical Institute at Randolph Center find their services in demand by private contractors and State highway departments in the New England States.

"Extension training program enrollments which have increased each year since the inception of the program account for 68 percent of the total enrollment. Effective extension programs for technicians grow out of the needs of employed technical workers and are of sufficient length to meet these needs. Extension programs frequently take the form of curriculum-based unit courses arranged in appropriate sequence so that the student may make orderly progression toward his goal. Some technical workers may only require a single course from time to time to keep them abreast of the rapid technological changes in their field.

"The increase of extension enrollments from year to year and the extent of extension training in the total program is truly indicative of the rapid changes in industrial technology and the needs of technical workers to keep pace with the rapid developments in their fields. New materials, new processes, and new products emerging from expanding research and development activities in recent years and resultant occupational changes have demonstrated the need for continuous study on the part of technical workers.

"A sampling of reports from the States illustrate the role of extension training programs in the industrial complex. The Seattle area in Washington has become a location for the production of strategic defense products including large aircraft manufacturing plants. With the changeover from aircraft to missile production, extension courses were developed to retrain technical workers for new jobs with minimum disruption of employment and the local economic situation. Similar instances have been reported in aircraft manufacturing plants from the East Coast to California where missile production replaced manned aircraft. In Alaska, Ketchikan Community College and Anchorage Community College are operating extension courses in electronics for personnel employed in defense installations. Texas reports that extension training programs provided for technical personnel have enabled electronics, petrochemical, and aircraft industries to fulfill work contracts.

" Area Vocational Education programs were conducted in 49 States and two territories during fiscal year 1961. An increasing number of States have enacted legislation designed to implement Title VIII programs. Competition among the States in attracting new industries to locate within their boundaries coupled with industry's interest in the availability of effective vocational education facilities for the training of technical workers have added further stimulus to area vocational education programs. Ohio and Oregon report new legislation designating junior colleges as area schools and in Colorado, Indiana, Kansas, Maryland, Minnesota, and Missouri changes in existing laws will stimulate area vocational training programs. Other State legislatures are providing funds to accelerate this type of training including Kansas, Oregon, and Utah. The New Hampshire legislature has provided $1,600,000 for the establishment of a State Technical Institute. In Connecticut, the Norwalk Technical Institute and the Hartford Technical Institute are now located in their new quarters and funds have been made available for two more technical institutes to be located at Norwich and Waterbury. The North Carolina legislature has appropriated $7,433,000 to speed the completion of 20 industrial education centers strategically located throughout the State. Georgia is speeding construction of area vocational schools throughout the State. In Illinois, three junior colleges are being organized by cooperating school districts in order to serve their area needs. The State board for vocational education and the junior colleges in Kansas are jointly formulating plans for the development of a Statewide technical program at the post high school level.

"Since the inception of Title VIII more than 100 surveys and studies to determine technical training needs have been conducted throughout the country in cooperation with the Department of Labor and other agencies. Some recent surveys include "The Manpower Requirements in Electronics Manufacturing--Outlook to 1964 in the New York Metropolitan Area;" "The Need for Technician Training and Upgrading in the State of Hawaii;" and a "Technical Employment Survey, Commonwealth of Puerto Rico."

"State and local expenditures for area vocational education programs were indicative of the stimulus provided by the financial assistance to the States under Title VIII. A total of $10,275,848.83 State and local funds was used by area schools for fiscal year 1961 in comparison to $7,913,336.99 of Federal funds. Overmatching by the States totaled $2,362,511.84.

"Many States report excellent relations between the schools and industry in organizing and operating technical education programs. Advisory and consultative committees composed of representatives of management and labor, and functioning at State and local levels rendered invaluable aid in assisting with curriculum construction and other phases of the program. In California, the Bay Area Council for Electronics Education is assisting the schools and school advisory committees in developing electronic programs. Foothill College and the University of California at Berkeley are working with the Northern California section of the American Ceramic Society in the development of a Ceramic Technology curriculum. At Modesto Junior College a study is underway in cooperation with 12 agricultural companies to identify and study the scope, skills and needs of the technician in agriculture. In Minnesota, personnel at the Minneapolis Area School are working closely with the Twin Cities section of the Instrument Society of America in the development of a 2-year curriculum in Instrumentation to meet the needs of industries in the area.

"During the year the Office of Education provided consultative service and assisted in program development through visitations to the States. Regional conferences called by the Area Vocational Education Branch of the U.S. Office of Education have also contributed materially to the implementation of Title VIII programs. The main objective of these conferences was to develop ways and means for achieving quality in the basic elements of a technical education program.

"Between February 27 and May 10, seven regional conferences involving more than 400 Title VIII State and local personnel were held in Baltimore; Atlanta; Springfield, Massachusetts; Pittsburgh, Pennsylvania; Oklahoma City; Pocatello, Idaho; and Minneapolis. Conference discussions dealt with curriculums, equipment, student selection, instructor recruitment and training, and supervision. A special conference on data processing for 50 State and local Title VIII personnel was held in Poughkeepsie, New York, July 10-12.

"Suggested curriculum guides in business data processing, mechanical, and chemical technologies based on materials prepared under contracts by Orange Coast College of California, the Milwaukee Technical Institute, and the Connecticut State Department of Education respectively, are nearing completion and will be distributed to the States. Other publications under preparation by the Area Vocational Education Branch include "Occupational Criteria and Curriculum Patterns in Technical Education Programs," and three publications which give job descriptions and suggest techniques for determining courses of study in mechanical technology - design and production, chemical and metallurgical technology, and civil and highway technology. Publications completed and distributed to the States were "Determining Requirements for Development of Technical Abilities through Extension Courses," "An Annotated Bibliography of Surveys and Studies in Vocational-Technical Education" and the Kansas City conference report "1960 National Conference of State Supervisors of Title VIII Programs." The monthly general information circular letter designed to keep personnel in the States informed on program and technological developments continues to be in demand by the States. Two articles written by Area Vocational Education staff members on technical education received wide attention through national publications.

"The staff also assisted the U.S. Agency for International Development with the orientation of foreign technical educators; conferred with the Panel on Technician training of the Office of Civil and Defense Mobilization on progress made by Title VIII programs and plans for the further development of technical education; and worked with the Bureau of Labor Statistics in the preparation of the technician training section of the "Occupational Outlook Handbook." Representatives of organized labor and industry assisted in determining how the program might best be used in the training of highly skilled craftsmen for more complex technical operations.

"Title VIII programs have grown vigorously during the first three years of operation despite limiting factors to program development. Although the circumstances varied, the three problems most commonly encountered in the States were: the lack of physical plant to house new laboratories; the need for instructional materials for technical curriculums; and the recruitment and training of technical teachers. The suggested curriculum guides now being prepared by the Area Vocational Education Branch will assist the States in developing instructional materials for technical programs. In most States the recruitment of highly qualified instructors for preparatory and extension programs offered during the evening hours was not unduly difficult. However, many States reported that the recruitment of full-time instructors for day preparatory programs continues to present problems mainly because of the difference between salaries in school and industry. While industry has cooperated wholeheartedly in making instructors available, and advisory committees have assisted in the recruitment of qualified personnel, the basic problem of providing adequate salary scales remains to be solved at the State and local levels.

"An increasing number of States conducted Statewide conferences and workshops for technical instructors, supervisors, and administrators. Teacher education programs for administrators, guidance counselors, and both full-time and part-time technical teachers are in varying stages of development in a number of States including Pennsylvania, North Carolina, Florida, Oklahoma, Illinois, Indiana, Texas, Colorado, California, and Michigan. Special summer institutes designed to update the technical competencies of instructors were conducted at the University of Illinoos and the University of Houston under the sponsorship of the National Science Foundation.

SIGNIFICANT OUTCOMES:

"One of the most significant outcomes of Area Vocational Education programs could well be the increasing public awareness of the role of the technician in this era of rapid technological change and the opportunities that technical education programs through Title VIII are providing for the youth of the nation. Enrollments in long established 2-year technical education institutions have varied little from year to year despite an increasing demand for highly skilled technicians. Colleges, on the other hand, are continuously trying to cope with the increasing number of high school graduates seeking admission. Too many of our well-qualified young people have not been aware of the advantages or even the existence, of 2-year technical education programs offered by technical institutes, junior and community colleges, and the job opportunities that stem from these programs.

"There is evidence that Title VIII has awakened the interest of both educators and the public in this previously neglected area of training. Area vocational education programs at the post high school level are becoming more numerous as State legislatures provide enabling legislation and funds.

"Other outcomes include: the contribution that extension programs are making in retraining technical workers to keep pace with occupational changes; the continuing emphasis on the quality of offerings in the various curriculums; wider acceptance of area schools which utilize the resources of larger areas with a greater population and lead to more education per tax dollar; and the development of a better understanding of technical education in the States."

Statistical data on schools, types of programs and enrollments in Title VIII programs are shown in the following tables. The data are provisional figures, subject to final review of State reports.

TABLE XX. TITLE VIII - ENROLLMENTS BY TYPE OF PROGRAM

Type of program	1960	1961
Preparatory programs:		
Secondary	8,467	11,778
Post Secondary	24,470	27,446
Total preparatory	32,937	39,224
Extension courses:		
Total enrollment	68,342	83,728
Total - Preemployment and extension	101,279	122,952

TABLE XXI. TITLE VIII - NUMBER OF PROGRAMS BY TYPES OF SCHOOLS

Kind of school	Preparatory programs		Extension courses	
	1960	1961	1960	1961
Comprehensive high school	160	114	255	269
Vocational-technical high school	23	89	72	133
Technical high schools	29	113	58	88
Vocational or trade school	175	133	209	181
Technical institute	47	30	56	138
Community or junior college	134	211	184	302
4-year college	20	33	34	72
State Board for Vocational Education	2	9	6	18
Other	8	-	31	-
Totals	598	732	905	1,201

TABLE XXII. TITLE VIII - ENROLLMENTS BY TYPES OF SCHOOLS - 1960-61

Type of school	Number of schools	Enrollment		
		Preparatory	Extension	Total
Comprehensive high school	168	4,611	14,160	18,771
Vocational-technical high school	66	4,457	9,404	13,861
Technical high school	49	5,968	8,494	14,462
Vocational or trade school	106	6,404	8,896	15,300
Technical institute	25	1,828	9,547	11,375
Community or junior college	176	13,743	28,844	42,587
4-year college	17	1,830	3,692	5,522
State Board for Vocational Education	13	383	691	1,074
Totals	620	39,224	83,728	122,952

TABLE XXIII. TITLE VIII - ENROLLMENTS IN PREPARATORY PROGRAMS BY TYPES OF SCHOOLS, BY LEVELS - 1960-61

Type of school	Secondary	Post Secondary	Total
Comprehensive high school	3,654	947	4,601
Vocational-technical high school	1,432	3,035	4,467
Technical high school	4,988	980	5,968
Vocational or trade school	1,316	5,088	6,404
Technical institute	108	1,720	1,828
Community or junior college	250	13,493	13,743
4-year college	21	1,809	1,830
State Board for Vocational Education	9	374	383
	11,778	27,446	39,224

TABLE XXIV. TITLE VIII - ENROLLMENTS BY TECHNOLOGIES - 1960-61

Technology	Preparatory		Extension	
	Number of programs	Enrollment	Number of programs	Enrollment
Electronics	292	17,713	431	42,243
Mechanical	249	11,959	278	17,128
Electrical	73	4,043	109	4,825
Aeronautical	12	655	12	831
Chemical and metallurgical	32	1,577	73	5,994
Civil and construction	34	1,090	32	995
Instrumentation	13	829	43	1,781
Production	11	934	61	3,310
Data processing	11	298	141	5,693
Nucleonics	-	-	6	290
Plastics	1	7	3	201
N.E.C.	4	119	12	437
	732	39,224	1, 201	83,728

TABLE XXV. TITLE VIII - FEMALE ENROLLMENTS BY TECHNOLOGIES - 1960-61

Technology	Preparatory	Extension	Total
Electronics	127	1,496	1,623
Mechanical	156	508	664
Electrical	15	23	38
Aeronautical	1	15	16
Chemical and metallurgical	50	68	118
Civil and construction	4	10	14
Production	1	260	261
Data processing	119	1,734	1,853
N.E.C.	-	73	73
	473	4,187	4,660

The first group of technicians was graduated from 2-year preparatory Title VIII programs in June, 1961. The States were requested to make follow-up studies of these graduates to determine how many were employed, the starting salary range, and the fields of work in which they were employed. Reports from 38 States, the District of Columbia, and Puerto Rico provided the data shown in Tables XXVI and XXVII.

TABLE XXVI. STATUS OF GRADUATES OF TITLE VIII PROGRAMS, BY TYPE OF SCHOOL 1961

	Secondary School	Post Secondary School	Total
Total number of graduates	1,600	4,834	6,434
Graduates available for placement	953	3,760	4,713
Placed in field of training	610	2,905	3,515
Placed in related field	113	270	383
Placed in non-related field	67	31	298
Graduates not available for placement	647	1,074	1,721
Continuing their education	484	550	1,034
Entered Armed Forces	137	437	574
Other reasons	26	87	113
Unemployed	16	90	106
Status unknown	152	259	411

Based upon the data from graduates whose status was known, in Table XXVI, the percentage distribution for 6,023 graduates is as follows:

	Secondary School	Post Secondary School	Total
Placed in field of training or related field	49.7%	69.5%	64.7%
Continued their education	33.3	12.0	17.2
Entered Armed Forces	9.5	9.6	9.5
Placed in non-related field, not available for employment, or unemployed	7.5	8.9	8.6
	100.0%	100.0%	100.0%

Appreciable differences are noticed in the above data between the proportions in secondary and post secondary programs with respect to placement in the field of training, and continuance of education.

TABLE XXVII. INITIAL SALARY OF GRADUATES BY OCCUPATIONAL FIELDS - 1961

Occupational field	Number placed	Salary Average	High	Low
Aeronautical	35	$4,100	$6,000	$3,000
Chemical	39	4,150	6,600	2,950
Civil	353	4,900	6,500	3,400
Data Processing	152	4,600	5,900	3,500
Electrical	372	4,200	5,400	2,950
Electronics	1,523	4,400	5,500	3,300
Instrumentation	153	5,600	6,000	4,160
Mechanical Drafting and Design	624	4,000	4,950	2,800
Mechanical Production	156	4,200	6,550	3,200
Metallurgical	53	5,500	8,000	3,600
Other	55	4,350	4,500	3,500

The average initial salary for graduates from secondary programs was reported as $4200, and that for post secondary graduates as $4600.

Fiscal Aspects of Title VIII Programs

The total authorization of Federal funds under Title VIII of the National Defense Education Act was $15,000,000. The appropriations made for the years to date are as follows:

Fiscal 1959	$3,750,000
Fiscal 1960	7,000,000
Fiscal 1961	9,000,000
Fiscal 1962	12,800,000

As an example of the way the funds are distributed among the States, Table XXVIII shows the allotment for the fiscal year ending June 30, 1960.

TABLE XXVIII. ALLOTMENT OF FEDERAL FUNDS TO STATES AND TERRITORIES FOR AREA VOCATIONAL EDUCATION PROGRAMS UNDER TITLE III OF THE GEORGE-BARDEN ACT (TITLE VIII OF N.D.E.A.) FOR FISCAL YEAR ENDING JUNE 30, 1960.

Total appropriation $7,000,000			
Alabama	194,565	Nevada	31,961
Alaska	35,780	New Hampshire	31,961
Arizona	34,194	New Jersey	123,420
Arkansas	144,781	New Mexico	37,454
California	323,209	New York	397,642
Colorado	57,671	North Carolina	280,948
Connecticut	61,025	North Dakota	53,056
Delaware	33,005	Ohio	299,160
Florida	105,427	Oklahoma	123,972
Georgia	207,686	Oregon	71,743
Hawaii	33,319	Pennsylvania	358,500
Idaho	40,592	Rhode Island	34,404
Illinois	291,267	South Carolina	142,600
Indiana	181,340	South Dakota	52,347
Iowa	160,072	Tennessee	207,164
Kansas	102,738	Texas	349,036
Kentucky	197,752	Utah	31,961
Louisiana	140,474	Vermont	31,961
Maine	45,493	Virginia	183,836
Maryland	85,019	Washington	99,284
Massachusetts	123,675	West Virginia	115,478
Michigan	239,428	Wisconsin	173,008
Minnesota	162,553	Wyoming	31,961
Mississippi	184,626	Dist. of Col.	34,264
Missouri	196,112	Guam	18,940
Montana	37,471	Puerto Rico	174,598
Nebraska	80,597	Virgin Islands	9,470

Source: Office of Education C.L. 3411

Study of the allotments in Table XXVIII shows the relatively high amounts received by States with large farm and rural populations.

Many of the States were unable to utilize the full allotment and this was reapportioned among States that were in position to utilize more funds than those provided in their original allotments. This reallocation of funds was as follows:

	Original allotment	Released from allotment	Number of States
1959	$ 3,750,000	$ 584,126	20
1960	7,000,000	620,607	12
1961	9,000,000	1,487,166	22

Expenditures for programs under Title VIII for the fiscal year 1960, as shown in the Annual Reports of State Boards for Vocational Education to the Office of Education (59) show the following:

State funds	$2,925,395
Local funds	5,132,997
Total State and local funds	8,058,392
Federal funds	5,968,137
Total funds	$14,026,529

The enrollment for the fiscal year 1960 showed a total of some 33,000 students in preparatory programs and some 68,000 in extension classes, with a total enrollment of 101,000.

An Appraisal of the Title VIII Act and its Operation

It is sometimes hazardous to make appraisals unless one has had adequate opportunity to examine fully all aspects of a situation. The writer has not had such opportunity with respect to Title VIII. During the first year of its operation he served as consultant to the Assistant Commissioner for Vocational Education, assisting him in planning the program, and during the second year he worked as consultant with the staff of the Area Vocational Education Branch. Subsequently he has served for short periods as consultant with two of the States in helping to implement their programs. In the preparation of this report he has communicated with leaders in several States, and has reviewed much of the material that has been published concerning the development and operation of the Act. Within this frame of reference the following observations are made with respect to his appraisal of the Act itself and its implementation.

Some comments on the Title VIII Act.

1. The Title VIII Act is tied in with out-of-date legislation for vocational education -- the Smith-Hughes and George-Barden Acts. The Smith-Hughes Act was passed in 1917, and was a good type of legislation for that period. (The writer worked with Prosser at the time the Smith-Hughes Act was passed and had opportunity to see it in operation during the early years.) As conditions changed, the Federal Board for Vocational Education, and later the Division of Vocational Education of the Office of Education, made changes in the regulations to bring the legislation more in line with these changing needs. But the basic provisions of the Smith-Hughes Act are still there, modified to some extent in the George-Barden Act of 1946. In the opinion of the writer, the time for amendments to the old legislation has passed, and the time arrived for Federal legislation for occupational education which is in keeping with present day conditions.

2. Specific items in the Act and the Regulations have caused trouble in interpreting the meaning of the Act and in its implementation.

a) The phrase "less than college grade," in the basic Act, at first glance would rule out all programs for which any kind of college credit is allowed. The interpretation of this phrase in the Regulations provides that programs may be approved if they do not lead directly to a baccalaureate degree, either within the institution or through transfer policies, and if the publications of the institution indicate that the courses are of "less than college grade."

There is strong objection to this phrase on the part of many institutions of 4-year college and community college type that offer occupational training programs two years in length. These institutions cannot control the transfer policies of other higher institutions, some of which may accept students from such programs and grant them credit toward a baccalaureate degree. Also these institutions which offer occupational training programs do not want to stigmatize their programs with "less-than-college-grade" pronouncements, as they consider their programs as a part of higher education. Some institutions with programs which could meet the requirements of Title VIII have refused subsidy because of this provision.

b) In Sections 801, 304 (a), and 307 (d) of the Act, reference is made to the skilled trades and to apprenticeship, implying that these may be included in acceptable programs. The regulations, however, limit the use of funds to the training of highly skilled technicians. No definition is provided for the expression "highly skilled technicians" which clearly differentiate these occupations from the skilled crafts.

c) Title VIII appears to have a dual purpose: 1) to strengthen vocational education programs of "area" type, and 2) to provide training for highly skilled technicians. These two objectives are compatible, but emphasis might be placed more on one objective than on the other. The training of highly skilled technicians is only one facet of area vocational education programs.

3. The basis of apportionment of funds among the States appears to the writer to be somewhat out of line with the needs, if the objective of the Title is the training of highly skilled technicians. The formula used for apportionment under the George-Barden Act provides that $10 million be allotted on the basis of farm population, $8 million on the basis of rural population, $8 million on the basis of nonfarm population, and $2½ million on the basis of total population. The allotments under Title VIII are based on the same ratios as the totals under the George-Barden Act. This provides a rather heavy weighting in favor of States with large farm and rural populations. A large portion of the programs for the training of technicians is extension courses for employed workers, and these are found largely in the urban areas. It would seem to the writer that a better allotment plan would place it on the basis of the total population.

A comparison of allotments under the present formula and on the basis of total population, for selected States, for the full authorization of $15,000,000, is as follows:

State	Allotment based on present formula	Allotment based on total population
Alabama	$418,828	$ 299,122
California	681,801	1,034,238
Connecticut	131,284	196,104
Florida	222,750	270,747
Illinois	627,416	851,150
Montana	80,788	57,741
New York	854,102	1,448,860
North Carolina	603,146	396,837
Wisconsin	372,212	335,546

The above figures, compiled in the Office of Education for comparison purposes, illustrate the changes that would occur with such a change of basis for allotments. Some of the highly industrialized States would get larger portions; some of the predominantly rural States would have lower allotments. Provision in the present Act for reallotment of funds not needed by certain States helps overcome the inequities, but it would be preferable if a State could count on the total allotment it would receive rather than to rely on the uncertainty of amounts available in reallotments.

4. Title VIII does not restrict programs to specific fields. It cuts across all the fields -- agriculture, trades and industry, etc. -- and programs may be approved in any field if they meet the requirements as provided in the Act and the Regulations. This is a desirable provision, as some programs cut across traditional fields of vocational education.

5. Programs under the Title are restricted to those needed for national defense purposes. The defense needs are so diversified that this provision apparently has not handicapped the development of technician training programs on a wide scale. The title leaves the interpretation of defense needs to the State boards for vocational education; thus there may be differences in interpretations among the States, and a program might be declared eligible for subsidy in one State and not in another. Future legislation for broad programs of technical education might well omit the defense need requirement.

6. The purposes for which funds may be used in connection with the development and operation of programs appear to cover all essential aspects. The freedom given to the States in their planning, with no restrictions as to amounts expended for surveys, equipment, etc., has been of great value in getting programs started.

Implementation of the Title VIII program.

Many problems arose in getting the programs under way in the States, and at the Federal level. Some groups in the field of technical institute education opposed the placing of the program in the hands of vocational educators. Some unions brought pressure to have skilled trades training included in the programs. Qualified personnel were difficult to secure. New administrative machinery had to be set up within the Division of Vocational Education of the Office of Education, and within the States. The urgency of needs brought pressure to get programs under way quickly. But in time these problems were met, and the programs started.

Many States used funds the first year to make surveys of occupational and educational needs, and these have been very useful in program planning. The availability of funds for purchase of equipment enabled the States to buy large amounts of laboratory equipment. Some of these expenditures were made perhaps too quickly, and some of the equipment purchased was probably of the wrong types and in the wrong amounts. But by and large the expenditures were appropriate ones. Considerable surplus equipment suitable for technical training was bought, at very low prices, by the institutions offering the programs.

The utilization of the administrative machinery of the Vocational Education Division of the Office of Education, and of the State boards, made possible a quick start. Extension courses were gotten under way rapidly, while plans were being laid for the preemployment programs.

The results to date of the Title VIII programs indicate a growing acceptance of the program as presently administered, increasing understanding of the problems of technical education, and increasing interest in further development of technical education. The dynamic leadership of the Area Vocational Education Branch, and the many services of the Branch, have contributed much toward this end. There are weaknesses in the programs, but on the whole the development under the Title has been qualitatively and quantitatively good.

19. PRESENT FACILITIES AND OUTPUT IN RELATION TO NEEDS IN TECHNICAL EDUCATION

This section of the report attempts to arrive at an estimate of the numbers of persons who should be enrolled in technical training programs in educational institutions in order to meet the needs of the economy in the years immediately ahead. To make an estimate of the needed enrollments in preemployment programs during the period from the present time to 1970, for example, one should have data on the following items:

1. The numbers employed in technical jobs at the present time.
2. The employment in technical jobs in 1970.
3. The numbers of workers who will leave technical jobs between now and 1970 through death, retirement, movement into other types of jobs, etc.
4. The numbers who will enter technical jobs through on-the-job training and through company training programs.
5. The numbers who will enter technical jobs through military training and experience.
6. The numbers of engineering college drop-outs who will enter technical jobs and retain them, and the numbers of engineering college graduates who will hold technician jobs temporarily.
7. The retention rates of the institutions which provide technical training.
8. The percentage of graduates of these institutions who enter technical occupations.

There are many difficulties in the way of gathering valid data on each of the foregoing items. Technical jobs have not been defined with accuracy, and there is great diversity in payroll titles. No nation-wide surveys have been undertaken which made a count of the numbers of workers employed in all the occupations of technical type. Estimates of employment in future years must include jobs found in new fields and in new establishments not now in existence. Reasonably accurate estimates can be made of the replacements needed due to death and retirement if valid data are available on the present workers. No data are available on the numbers of technicians and other technical workers who move into other types of jobs.

No data are available on the numbers who enter technical jobs through up-grading within industry or through organized in-plant training programs, although it is known that these numbers are substantial. No data are available on the numbers who enter civilian technical jobs through military training, although it is known that many electronics technicians got their start in the military schools. Reasonable numbers of engineering college graduates take technician and other technical jobs as entry occupations, and drop-outs from engineering colleges find such jobs in unknown numbers.

Without valid data on these items the only recourse is to utilize small bits of data gethered here and there as a base and project them to get the larger picture in the nation as a whole. The estimates thus developed are crude, but they do give direction for needed program expansion even though they do not provide valid quantitative data.

In section 7 an estimate was made of 200,000 technical workers needed annually in the years immediately ahead. The major sources from which these technical workers will come are: a) on-the-job training and in-plant training programs, b) the Armed Forces, c) engineering college graduates and drop-outs, and d) organized training programs for technical workers offered by public and private educational institutions. Estimates of the numbers to be supplied by these sources are as follows:

On-the-job training and in-plant training programs	36,000
Armed Forces technical schools	10,000
Engineering college graduates and drop-outs	13,000
Organized technical training programs in public and private educational institutions	141,000
Total	200,000

The number of workers to be provided through on-the-job training and in-plant training programs is a crude estimate based upon data found in the North Carolina survey (18) which indicated that approximately 18 percent of the technical workers required to supply the needs of industry in the years immediately ahead would come from this source.

With respect to the numbers of technical workers furnished through personnel released from the Armed Forces, the BLS survey of the mobility of electronics technicians estimated that one-third of the needs of industry for electronics technicians are met from this source. From data found in eight of the surveys outlined in section 2, the proportion of electronics technicians to total technicians varied from 6 percent to 48 percent with a

median of approximately 15 percent, which was the approximate proportion found in the larger surveys. One-third of 15 percent provided the five percent used in estimating the average annual contribution from the Armed Forces. Relatively few technicians in other occupational categories than electronics are trained in the Armed Forces schools, and since the training programs in these schools are usually shorter than those normally found in educational institutions offering technician training it was felt that the five percent was as close an estimate as the writer could make.

In arriving at an estimate of the contribution of the engineering college to technician workers in industry, the average numbers of engineers needed annually by industry in the period 1959-1969 was shown in the BLS study on the long-range demand for scientific and technical personnel (40) as 48,000 graduates with the bachelor's degree. The estimated number of freshmen required annually to produce that many graduates was determined by attrition data found in the Tolliver-Armsby study of engineering enrollments and degrees (58) as 92,000 annually, and from other attrition data in that study it was estimated that 11 percent of these freshmen would remain only two years in engineering college. This would show approximately 10,000 dropouts at the end of the second year. An arbitrary estimate was made that 30 percent of these dropouts would enter technician jobs, or a total of 3,000 (43). It was assumed that those who dropped out at the end of the first year of engineering college, where the heavy attrition occurs, would not have received sufficient technological training to be able to fit into technician occupations without considerable training, and that this potential source should be omitted. The two-year dropouts would also require additional training to develop competency as technicians.

The number of bachelor's degree engineering graduates who would enter technician jobs, usually as entry jobs on the engineering occupational ladder, was arbitrarily estimated at 20 percent. This would provide approximately 10,000 technical workers annually. Since these graduates would usually occupy technician positions for only perhaps one year or so, the turnover would vacate that number of jobs annually.

The total number of workers estimated to be supplied by the sources described above is 59,000, if one can include the temporary engineering graduate workers. This leaves a total of some 141,000 technical jobs to be filled annually by graduates of technical training programs in public and private educational institutions. This is predicated upon estimated needs in accordance with expressed desires on the part of industrialists as outlined in section 2. All of these jobs are not of engineering technician type; some are industrial technicians and technical specialists. The numbers needed appear very large, yet the writer believes them to be realistic. In comparison, the number of graduates from semiprofessional engineering-industrial schools in Soviet Russia in 1959 was 264,800 (13).

If some 141,000 persons are to be graduated from technical training programs annually to meet the needs of American industry, great expansion will be required in enrollments, in present programs and in new programs. Some increases in enrollments can be made in present curriculum offerings. Some can be provided through expansion of the plant and programs of existing institutions. Much will need to come through new institutions. In what types of institutions should this expansion take place?

At the present time, training for these technical occupations is provided through technical programs in high schools, vocational schools, technical institutes, junior/community colleges, and 4-year collegiate institutions. Some of the needed expansion will come in private institutions, and this might be stimulated by appropriate financial aid from public funds. Most of the expansion will need to come in public institutions.

Technical training programs in high schools are now providing substantial numbers of graduates. The report of enrollments in Title VIII programs for the year 1960-61 showed enrollments in preparatory programs of 11,778, as compared with enrollments of 27,446 on the post secondary level. The Title VIII programs comprise only a portion of the total enrollments in technical training programs. Data are not available that show the total picture. There is overlapping of enrollments reported in the different surveys. It is apparent, however, that the proportion of enrollments of post secondary type in the country as a whole is considerably higher than the ratio found in the Title VIII programs.

The report on what happens to graduates of Title VIII programs (Table XXVI) shows that one-third of the graduates from secondary programs continued their education, and one-half were placed in jobs of technical type; as compared with 12 percent of the post secondary graduates who continued their schooling, and 70 percent placement in technical jobs. Some 10 percent of each group entered military service, many of whom will later return to civilian technical employment with additional training provided by the Armed Forces. Graduates of the secondary programs entered industry at salaries some 9½ percent lower than those from post secondary programs.

The graduate of a secondary technical training program usually starts to work at an age two years lower than the post secondary graduate, and is earning wages while the other is still in school and is being provided with technical training largely at public expense. The graduate of the secondary technical program has had to omit in his high school career some courses in general education he might otherwise have taken, and enters work life with two years less of formal education. The lack of a credential from a post secondary institution may handicap him later in meeting civil service and similar job specifications, and in certification as a technician if and when that is provided. Taking into account the assets and liabilities of technical education on the secondary level, and the definite trend toward placing new programs on the post secondary level, it is the opinion of the writer that present programs on the secondary level should be continued as long as they show creditable results, but that no new programs for the training of engineering and industrial technicians be developed on that level. The

high school should adjust its curriculum offerings to provide prevocational foundation training on a broad basis, with specialization coming in the post secondary years. On this premise it is suggested that expansion of preemployment training on the secondary level be limited to institutions now offering technical training which are in a position to increase their enrollments without heavy expenditures for plant and equipment.

No data are available to the writer with respect to enrollments in high school technical programs beyond those furnished in the Title VIII report. The total enrollments may be substantially higher than those shown. If the enrollments in secondary technical programs could be increased from the present enrollments (some 12,000 under Title VIII and some in other programs) to 20,000 enrollments, perhaps this is as high a goal as should be set. With carefully selected students the attrition rate should not be excessive. If a three-year program is assumed, and sixty percent of the 10th grade students enrolled in the programs might be expected to be graduated, an enrollment of 20,000 students might produce 5,000 graduates annually. If 60 percent of these graduates found technical jobs in industry, either directly after graduation or subsequent to service in the Armed Forces, the numbers furnished to industry from the secondary technical programs would be 3,000 annually.

This is a very small number to be furnished by secondary technical training programs. An effective technical education program requires the enrollment of substantial numbers of students, extensive and costly equipment, and qualified technical instructional staff. This is not easily secured in a comprehensive high school, and specialized technical high schools are appropriate only for the larger cities. Most high schools of the nation are too small to undertake effective preemployment training of technical type. In the light of all these factors, it seems appropriate to concentrate the needed expansion in post secondary institutions rather than in high schools.

The numbers of graduates from technical training programs in post secondary schools at present is relatively small in comparison with needs. In his survey of enrollments and graduates in engineering technician programs, limited to programs accredited by E.C.P.D. or considered to be of equivalent types, Metz reported as shown in Tables XXIX and XXX (35) & (36).

TABLE XXIX. ENROLLMENTS IN ENGINEERING TECHNICIAN PROGRAMS - 1959-1961

	1958-59	1959-60	1960-61
Institutions with at least one ECPD-approved curriculum	27,940	26,334	23,808
Other institutions	50,599	53,450	47,914
Totals	78,539	79,784	73,497

The reader is referred to the sources of data in Tables XXIX and XXX, (35) and (36), for differences in reporting for the different years. The data include enrollments in full-time curriculums, and in part-time programs where the student is pursuing a long-term curriculum. Some 200 schools are included in the reports. Metz interprets the downward trend in institutions with at least one ECPD-approved curriculum to stiffening standards as well as to economic conditions. Approximately half of the schools with ECPD-approved curriculums are privately operated.

TABLE XXX. GRADUATES IN ENGINEERING TECHNICIAN PROGRAMS - 1959-61

	1958-59	1959-60	1960-61
Institutions with at least one ECPD-approved curriculum	7,203	7,639	7,184
Other institutions	8,424	8,457	8,070
	15,627	16,096	15,254

The data in Table XXX include graduates from part-time curriculums as well as full-time programs. Graduates from the full-time programs for 1960-61 were reported as numbering 10,675 from 176 institutions.

Comment on the Metz Survey by the staff of the Engineering Manpower Commission (19) is as follows:

> "Small comfort is drawn from a report that our already short supply of engineering technicians has little prospect of improving. According to a survey by Donald C. Metz, member of the Engineering Manpower Commission, and Director of Technical Institute, University of Dayton, the number of full-time students

enrolled in technical institutes is about 40,000, or 9% fewer than enrolled in 1957. Total college enrollments rose 27% during the same period of time.

"This means our already short supply of engineers will be further handicapped by an even shorter supply of capable engineering technicians to help carry forward the nation's technological commitments. The inevitable result will be some extremely undesirable utilization practices. Engineering technician shortages will force assignment of highly technical functions to those who are poorly qualified. Even less desirable, many highly qualified engineers will waste precious time with work which could better be done by competent engineering technician associates.

"In years passed, we have been able to "gear up" for emergencies with great speed. As recently as World War II, the U.S. was able to quickly mobilize its war production with the limited technological manpower available. Today, however, a similar feat will be extremely difficult if not impossible. Science and engineering have gone too far to justify a "we did it before, we can do it again" attitude. Already, there is reason to believe that our present commitment to technological programs exceeds the availability of engineers, scientists, and technicians. One dramatic example is the effort of the National Aeronautics and Space Administration to recruit over 2,000 engineers before July, and another 2,000 before the end of the next fiscal year. This manpower requirement only covers the in-house program or 10-15% of NASA funds. The rest is being contracted to industry, and will result in a proportionately greater manpower requirement.

"If we had enough qualified technicians available, engineers might be able to stretch their talents much farther. How far? Some experts believe that the optimum ratio is four technicians for every engineer. A conservative evaluation would call for at least two technicians working with the average engineer. Based upon estimates of current graduates of technical institutes, we are now producing less than one-half a technician per engineer.----- Using the Metz survey as a base, total full-time enrollment in all technical institutes in the United States is estimated at 40,000 and total graduates for the year 1961-62, 16,000."

Data from the report on Title VIII programs show enrollments of 27,446 students in post secondary preparatory programs in 1960-61. These enrollments overlap those of the Metz survey to some extent, but include a considerable number not included there. How many is impossible to determine, from available data.

Data in the Office of Education survey of organized occupational curriculums report 12,985 graduates from engineering-related curriculums in higher education in 1957-58 (61), and 15,751 for 1958-59, reported in Higher Education, April 1961. These data also overlap those shown in the reports previously noted.

Total enrollments at present in all post secondary full-time programs which prepare persons for technician occupations probably number not more than 60,000 students. This is a long ways short of meeting present needs, even when supplemented by those enrolled in part-time preemployment programs.

If 141,000 technical workers are to be provided annually from technical training institutions, the numbers enrolled will need to exceed half a million students. Most of these are expected to be in post secondary schools. The graduates will come from full-time preemployment programs two years in length, and part-time preemployment programs extending over several years. School capacity needs to be planned largely on the basis of the numbers of full-time students, as the part-time students usually use the facilities at different hours from the full-time students.

Possibly 80 percent of the graduates might come from full-time programs, although the number of part-time preemployment programs appears to be growing. On this assumption, allowing for relatively small numbers to come from high school programs, some 110,000 graduates should come annually from full-time programs. Based upon 60 percent retention in the second year of a two-year program, and 75 percent of the graduates entering technical occupations, this number of graduates would require an enrollment of some 390,000 students in full-time programs of post secondary type, with an entering group each year of some 240,000 students.

If the United States is to meet the technological challenge of the present day, and is to maintain its place of leadership in the world economy, it must put forth strenuous efforts to provide its engineers and scientists with adequate supporting staff of technicians, and provide trained technical personnel for the already extensive and rapidly growing occupations in industry, business, and other fields that require technical training of semiprofessional level.

Programs Needed in Fields Outside Industry.

The foregoing discussion of technical training programs needed for the years ahead has been confined largely to the needs of industry. The estimates of 200,000 technical workers needed annually in the years immediately ahead did not include large numbers of technical workers in such fields as agriculture, business, and the health and medical fields. Time available for the preparation of the present report did not permit investigation of these fields. The numbers of technical workers in these fields are large, and are growing. This is an important sector of technical education for which facilities should be provided, in addition to those suggested above for workers in industry.

20. CONCLUSIONS AND RECOMMENDATIONS

For the reader who desires a quick summary of the report, here are some brief statements concerning the content and inferences drawn:

1. Rapid technological change is increasing the proportion of semiprofessional technical workers in industry.

2. Occupations on all levels are requiring increasing amounts of technology.

3. Technical occupations in industry form a continuum from narrow-scope limited-level jobs to those filled by highly skilled technicians.

4. Technical occupational groups for which educational institutions might offer training include engineering technicians, industrial technicians, and technical specialists.

5. Technician occupations cut across all sectors of industrial life.

6. Increasing numbers of jobs of technical type and level are emerging in occupational fields outside of industry.

7. Women are entering technical jobs in industry in increasing numbers.

8. The changing geography of industry is bringing the need for technical training to areas of the country not previously concerned.

9. The many recent surveys are bringing into focus the great need for technicians in American industry, and the increasing needs in the years ahead.

10. Industry now has a ratio of technicians to engineers of approximately .7 to 1. The need for increasing this ratio to at least 2 to 1 is becoming increasingly apparent.

11. On the basis of a ratio of two technicians to each engineer, there will be a projected need of some 200,000 new technicians annually in the years immediately ahead.

12. Technicians prepare themselves for their jobs in many different ways -- through on-the-job training, in-plant training programs, Armed Forces technical schools, and through organized technician training programs in technical institutes, community colleges, vocational-technical schools, and technical high schools. Some engineering college graduates and drop-outs enter technician jobs.

13. In the years ahead a high proportion of new technical workers will need to come from organized preemployment training programs in educational institutions.

14. Preemployment technical training programs are found in technical high schools, and in many types of post secondary institutions.

15. Post secondary institutional patterns include separate technical institutes, vocational-technical schools, community colleges, technical institute divisions of engineering colleges.

16. The technical institute has contributed much to the field of technician training. Though few in number, these institutions provide a substantial number of technicians annually.

17. The private technical institute has provided much leadership in the field of technician training, and has done much to maintain high standards and to promote development in the field.

18. The curriculum pattern for post secondary technician training includes basic and applied science and mathematics, drawing, a high proportion of applied technology, and some general education.

19. Many different curriculums are offered, and there is little standardization in curriculum content.

20. The community college has recently entered the field of technician training on a relatively large scale, and appears to be one of the promising sources of expansion in this field.

21. Vocational-technical schools of area type, under the stimulus of Title VIII funds, have shown great expansion in technician training programs since the passage of the Act.

22. The technical high school has provided training for technicians for many years, but the total enrollments have not increased materially.

23. Technician training appears to be moving definitely toward post secondary programs. The role of the technical high school will probably continue as at present, with relatively little expansion.

24. Evening and other part-time extension study forms a large and important part of the total program of technical education. It ranks of equal importance with the preemployment program.

25. Correspondence study plays an important part in the education of technical workers; many thousands are enrolled in technical courses.

26. Curriculums for the preemployment training of technicians usually have as their objective the preparation of persons for a cluster of closely related occupations rather than for a single technical occupation.

27. Accreditation of post secondary institutions offering technical training programs is provided by State and regional accrediting agencies. Curriculums are accredited by State agencies and by the Engineers' Council for Professional Development. The number of specific accredited curriculums is small as compared with the total number of curriculums offered.

28. Graduation from post secondary preemployment technical training programs is recognized by certificate, diploma, or the associate's degree. The associate's degree is becoming increasingly popular.

29. Capital outlay costs for post secondary technical training programs of good quality is estimated at from $3,000 to $4,000 per full-time student.

30. Operating costs for post secondary technical training programs vary widely in different institutions. The cost of a quality program is estimated at $800 per year per full-time student.

31. Much new construction of plant for technical training has been added in the past few years.

32. The student potential capable of satisfactory achievement in two-year post secondary programs of various types is estimated at 250,000 new students annually at present, with a total potential enrollment in such programs of some 400,000 students, of which a substantial proportion might be enrolled in technical curriculums. The estimated total potential enrollment for 1970 is some 590,000 students.

33. The student potential includes both male and female students. If maximum potential enrollments are to be attained, greatly increased numbers of young women will need to be enrolled in post secondary occupational training programs.

34. Guidance programs in secondary schools now give less attention to informing students about technician training than is given concerning professional training. More effort should be put forth in the education of counselors toward getting better guidance service for potential students for technician training programs.

35. Many agencies of different types are concerned with technical training -- manpower councils, trade associations, professional associations, educational associations, and the like.

36. A greatly expanded program of research in technical education is needed.

37. Attention needs to be given to the development of training programs of technical type in fields outside industry, such as agriculture, business, medicine and health.

38. The Title VIII program for the training of highly skilled technicians has worked out well, in spite of many difficulties. Programs developed under the Act have added considerably to the numbers prepared for technical occupations through the preemployment and extension programs. The graduates have secured jobs at good salaries. The results to date indicate a growing acceptance of the program as presently administered, increasing understanding of the problems of technical education, and increasing interest in its development. Leadership of the program in the Office of Education and in the States has generally been forceful and effective.

39. Present output of trained technical personnel falls far short of meeting the needs of industry; and projected needs of industry in the years ahead indicate a widening gap between present facilities and these needs.

40. To meet the estimated needs of 200,000 new workers annually in the years immediately ahead will require that some 140,000 of them will have to come from preemployment training programs in the public and private educational institutions of the nation.

41. Of the 140,000 new workers needed to be trained annually in educational institutions, some will be trained through part-time preemployment programs, with an estimated number of 110,000 to come annually from the full-time programs. This will require an enrollment of some 390,000 full-time students, with an entering group each year of some 240,000 students.

42. Present total enrollments in full-time training programs in educational institutions are roughly estimated at 60,000 students -- far short of the needs.

43. Strenuous efforts will be needed if the educational institutions of the nation are to meet the needs of industry for technical workers, and thus help maintain the position of the United States in world technological development.

Some Questions and Issues Concerning Technical Education

In preparing this report a number of questions and issues have arisen that have important bearing on the future of technical education. Here are some of them:

1. How can the term "technician" be defined so that the average citizen can understand what is meant? Should it be prefixed by adjectives, such as "engineering technician" or "industrial technician?" How shall we label the other technical jobs in industry of narrower scope than those now called technicians by many persons?

2. What is meant by "higher education?" Does it mean any education that requires high school graduation for entrance? Does it include other programs which admit persons of maturity who are able to profit from the instruction even though they have not completed high school?

3. Should Title VIII be continued as a part of the George-Barden Act, subject to many conditions (such as the "less-than-college-grade" provision) that were designed for vocational industrial education as it existed many years ago?

4. Should the training of "engineering technicians" be restricted to certain types of institutions?

5. How should programs for the training of technical workers be accredited?

6. What is the most appropriate administrative agency for Federally aided programs of technical education -- within the Office of Education and within the States?

7. What types of Federal aid for technical education are desirable: plant and equipment? operating costs? teacher training? research? aid for students?

8. Should any form of Federal aid be provided for private nonprofit schools?

9. Should the scope of technical education aided by Federal funds be broadened to include fields such as agriculture, business, medicine and health, and the like?

No attempt is made in this report to answer all of these questions. The writer, however, has some convictions with respect to certain of them. He believes that:

1. Any new legislation for technical training should not be subject to the provisions of the George-Barden Act.

2. Any new legislation for technical training should not limit the aid to institutions of any single type, such as technical institutes, but should include all institutions capable of doing the job in accordance with appropriate high standards.

Perhaps the best type of institution for the training of highly skilled technicians is the <u>separate technical institute</u>, operated on its own campus, with adequate modern equipment, with a competent faculty, with high level leadership, with appropriate preemployment and extension programs, with curriculums that meet high standards, and located where it can serve the needs of employed workers as well as others. It has singleness of purpose, not dividing its interests with engineering programs, skilled trades training, or academic curriculums. The numbers of such institutions are limited, and the prospects for any large expansion of institutions of this type are not bright at present.

The <u>area vocational-technical school</u> can do a good job in technical training if certain conditions are met:

a) The leadership of the institution really understands the task of technical training.

b) Proper curriculums are developed, and appropriate accreditation is obtained.

c) Adequate equipment of appropriate type and quality is provided.

d) Properly qualified staff members are secured.

e) Student selection is carefully done.

f) The technical training has its own entity, separate from that for the skilled trades.

g) Good relationships are maintained with industry through appropriate technical advisory committees.

It will fail if:

a) Vocational industrial education policies and practices are permitted to control the technical program.

b) The other conditions outlined above are not met.

The area vocational schools are growing in numbers and should be able to provide a considerable amount of technical training of acceptable quality. Many of them are looking forward to community college status.

The community college appears to be the most promising agency for nation-wide large-scale expansion of technical training. In many states the public technical-institute type programs are developing in the community college pattern. The community college is undergoing rapid development. It has wide-spread geographical coverage. It will succeed in technical training if it meets the high standards for equipment, curriculum, faculty, student selection, and administration outlined above. It will fail if:

a) The technical training program is not given adequate attention and good leadership.

b) Curriculums are patterned after the preengineering programs.

c) Attempts are made to utilize existing courses not designed to meet the needs of technical students.

d) The general regulations of the institution demand a higher proportion of general education than technical students will accept.

e) Proper use is not made of technical advisory committees, and close contact with industry is not maintained.

The technical institute division of the engineering college should continue to function well in this field when its program is well administered, adequately equipped, and properly staffed. No great expansion of this type of institution has been noted in recent years, and no definite trend in this direction is noted. Some leaders feel that with the increasing effort of the engineering colleges toward graduate study, and the increasing role of the community college in technical training, that perhaps the future contribution of the technical institute division of the engineering college may remain somewhat at the present status.

3. There is great need for unity of all educational groups in the field of technical training. In the opinion of the writer, the time has come for unified action on the part of all who are concerned with technical education -- within the Office of Education and within the States. The task of providing technical education of appropriate type and in adequate quantity is too important to be impeded by jurisdictional disputes.

Any new Federal legislation should make provision for appropriate aid for all types of institutions capable of rendering effective service in the field of technical training, but the aid should be administered on Federal and State levels through a single agency.

4. The responsibility for program planning and operation of technical training programs should rest with Federal and State educational agencies, with effective cooperation between these agencies and other pertinent governmental departments with respect to services they could render in determining needs for workers, and in other ways.

5. Any new Federal legislation for technical education should include provision for:

   a) Maintenance of adequate programs of administration, supervision, and teacher training.

   b) Salaries and necessary traveling expenses of State or local school personnel, including teachers, supervisors, directors, teacher trainers, and others.

   c) Travel expenses of members of advisory committees.

   d) Purchase, rental, or other acquisition, and maintenance and repair, of instructional equipment.

   e) Purchase of instructional supplies and teaching aids.

   f) Making of educational and occupational surveys necessary for proper program planning.

   g) Research in the field of technical education.

It should provide for the development of State plans for technical education, and for their review by the Office of Education.

Some additional questions remain unanswered in the mind of the writer.

Among these are the following:

1. What agency within the Office of Education should administer the program?

> The most appropriate agency might be a division of occupational education cutting across the present division of vocational education and that of higher education, with appropriate level on the organization chart, with general administrative policies patterned somewhat after those of the present division of vocational education.

2. What agency within the State should administer the program?

The pattern used for the administration of State programs of vocational education has worked well for that program. Some States have one board for all education; some have separate boards for higher education. At least one State has a State Board for Vocational Education separate from the State Board of Education. Creation of a new State Board has its drawbacks. The State Board for Vocational Education has worked out satisfactorily in most cases for the Title VIII program. Perhaps this is the one to use.

3. Should legislation include funds for buildings? Should it include funds for student aid? Should private institutions share in the Federal funds made available under the legislation?

These are broad questions pertaining to all types of Federal aid for education, and the writer has no comment to make concerning them in this report.

<u>How much will it cost</u>?

The overall cost of a program that will meet the needs as outlined in this report is very great. Costs for plant and equipment to provide training for an enrollment of 390,000 full-time students in post secondary institutions, at $3000 per student, would amount to about $1½ billion dollars. Fortunately some plant is already available, and present plant might accommodate increased enrollments above those at present. The operating cost annually, at $800 per full-time student, would amount to some $300 millions per year. The total cost would be shared by local, state, and Federal governments.

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